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ABSTRACT

This document was produced through a partnership among business, education, and state government pursuing statewide improvement in the teaching and learning of K-12 mathematics and science through the implementation of national standards for science and mathematics and the Minnesota Graduation Standards. Opening Conversations is one public awareness effort that results from discussions with teachers that have participated in a professional development experience that focuses on inquiry learning and problem solving. The goal of this publication is to provide some tools of communication that educators can use as they attempt to inspire and convince others of the need to reform science and mathematics education. Topics considered in detail include the nature of conversation in context, inquiry communication in action, conversation points to use as springboards for discussion, communication tools, and a list of resources on a variety of educational topics. (DDR)

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OPENING CONVERSATIONS

ED 412 082

An educator's guide to communicating in a changing world

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OPENING CONVERSATIONS

An educator's guide to communicating in a changing world

Developed by SciMath[MN],
a partnership among education, business and state government pursuing statewide improvement in the teaching and learning of K-12 mathematics and science based on the national mathematics and science education standards and the Minnesota Graduation Standards.

1996

SCIMATH[MN]

The mission of SciMath^{MN} is to increase the educational achievement and participation of *all* Minnesota students in science and mathematics to help them meet the complex challenges of their future.

Keep the Conversation Going...

We'd like to hear about your efforts in communicating about the mathematics and science standards and how you are using this guide. Let us know what's working — and what's not — and what additional tools would be helpful to you. Write, call or e-mail.

SciMath^{MN}
638 Capitol Square
550 Cedar Street
St. Paul, MN 55101
612-296-4058
FAX 612-297-7340
E-mail: scimath-mn@informns.k12.mn.us
Internet: http://www.informns.k12.mn.us/scimathmn

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PREFACE

Founded in 1993, SciMath[MN] is a partnership among business, education and state government pursuing statewide improvement in the teaching and learning of K-12 mathematics and science through the implementation of the voluntary national standards for mathematics and science education and the Minnesota Graduation Standards. SciMath[MN]'s mission is to increase the educational achievement of all Minnesota students in science and mathematics to help them meet the complex challenges of their futures.

In working towards fulfillment of this mission, SciMath[MN] works with business, education and policymakers as a catalyst for change in the educational system, with initiatives in the areas of policy, professional development and public awareness.

This Educator's Communications Guide is one public awareness effort resulting from discussions with teachers who have participated in SciMath[MN]'s Teacher Academy, an intensive two-week professional development experience in inquiry learning and problem-solving as envisioned in the national mathematics and science standards. In these discussions, teachers said they need help in communicating the changes involved in inquiry-based teaching as they integrate it into their classrooms. This guide has been specifically designed with the input of teachers to respond to that need.

Opening Conversations is intended for use by teachers who have completed the SciMath[MN] Teacher Academy professional development experience or have participated in other SciMath[MN] initiatives. However, it is also appropriate for use by any teacher who is committed to implementing the principles of inquiry learning as envisioned by the national mathematics and science standards and the Minnesota Graduation Standards.

In the belief that improving our educational system requires the involvement of the entire community, we hope this guide will help equip educators to open new conversations with others in their communities to help prepare *all* children for the complex challenges of the future.

Bill Linder-Scholer
Executive Director, SciMath[MN]

Our thanks go to the members of the 1995 SciMath[MN] Teacher Academy team from the Burnsville-Eagan-Savage school district who helped to shape this guide by generously sharing the challenges they face as they implement a standards-based approach to teaching of mathematics and science:

Sally Smith
Hidden Valley Elementary School, Savage, MN

Gina O'Reilly
Hidden Valley Elementary School, Savage, MN

Eileen Abrahamson
Edward Neill Elementary School, Burnsville, MN

Bob Mayne
Sky Oaks Elementary School, Burnsville, MN

Beth Anderson
Rahn Elementary School, Eagan, MN

This guide was developed by a team including Katie Bratsch of SciMath[MN], and Cynthia Hill, Sandy Rummel and Nancy Giguere of Rummel, Dubs & Hill. The staff of SciMath[MN] and the SciMath[MN] Public Affairs Committee contributed valuable support and guidance to the project.

This guide and other SciMath[MN] communication activities are made possible with the generous support of Alliant Techsystems.

"Conversation is the laboratory and the workshop of the student."

RALPH WALDO EMERSON

"Conversation warms the mind, enlivens the imagination...."

BEN FRANKLIN

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"A strong back, the willingness to work, and a high school diploma were once all that was needed to make a start in America. They are no longer. A well-developed mind, a passion to learn, and the ability to put knowledge to work are the new keys to the future of our young people, the success of our businesses, and the economic well-being of the nation."

WHAT WORK REQUIRES OF SCHOOLS,
A SCANS REPORT FOR AMERICA 2000

What in the World's Going On? The Need for a New Vision

Teachers: Catalysts for Change

Effective Communication: Taking It Beyond the Classroom

Four Stages of Inquiry Communication

How to Use This Guide

One Last Thing

What in the World's Going On? The Need for a New Vision

Our children today are growing up in a world that is changing at an unprecedented rate. Things we once took for granted — secure jobs, a stable economy, abundant resources — are far less certain today.

Ongoing developments in technology are changing the way we live every day, creating new jobs, eliminating others, and altering many fundamental requirements of the work place. Some futurists believe that nearly half of U.S. workers will be involved in collecting, analyzing and synthesizing information as we move into the 21st century. It's also expected that future workers will change jobs at least five times in a lifetime.

What does all this change mean for our children as they become tomorrow's workers and citizens? How can we prepare them to navigate the unpredictable path ahead, to successfully adapt and adjust to the complex challenges and the many possibilities of their future?

While there are no simple answers to these questions, educators in Minnesota and across the country have been considering how to adjust the educational program to bring it into alignment with the realities of the 21st century — in particular how to put greater emphasis on the higher-order thinking and problem-solving skills our youth will need for life in the 21st century.

Many of these skills and habits of mind are developed through the study of mathematics and science. Yet the ways these subjects have traditionally been taught have not successfully reached large numbers of our children, leaving many unprepared for future jobs and unable to use applied science and mathematics in a wise and responsible manner.

A powerful vision, practical guidance...

To better prepare our young people, our nation's science and mathematics communities have developed clear, high, voluntary standards for what all students need to know and be

"By standards, we don't mean the conventional kind of standard as a criterion or test score, but standard in its original definition, dating to the Middle Ages, which meant a banner at the head of a column of troops indicating the right way to proceed. In this sense both the national science and mathematics standards and the Minnesota Graduation Standards are a guidance system for us, indicating the general direction to go — a vision of how to get there, and some reference points. As such, they leave much work to those of us at the state and local level to determine the best paths to take."

BILL LINDER-SCHOLER
EXECUTIVE DIRECTOR,
SCIMATH MN

able to do. At the same time, the State of Minnesota has developed the Minnesota Graduation Standards, a set of performance expectations for graduation from high school.

Both the national voluntary education standards and state standards emphasize an approach to learning that fosters development of higher-order thinking skills and open-ended problem-solving — capabilities sought by employers and required in increasing numbers of professional fields.

With less of an emphasis on "seat-time" and rote memorization of facts, **this approach, often referred to as inquiry, encourages every child to question and think creatively, frequently working in groups on real-life problems, with the teacher serving as both facilitator and resource.**

To help schools move toward a greater emphasis on inquiry-based learning, the national and state standards offer teachers, administrators and communities a powerful vision and practical guidance for positive change needed at every level of the educational system.

The standards extend to the preparation of future teachers. Through SciMath MN's Transforming Teacher Education initiative, 19 Minnesota colleges and universities are looking at ways to redesign their teacher preparation programs so that beginning mathematics and science teachers will be prepared to teach according to the vision of the national and state standards and will continue to learn new content and new ways of teaching throughout their careers.

While these are positive steps toward integration of standards-based teaching and learning throughout the educational system, the improvements envisioned in the standards will take time to be realized. In the meantime, hundreds of classroom teachers who are doing inquiry are trailblazers. Through their engagement with students, their discussions with fellow teachers, their interactions with parents, administrators and the public in general, these teachers have the opportunity to influence the future as they create a base of support for their efforts.

Teachers: Catalysts for Change

Like you, teachers across the country are embracing inquiry-style learning in their classrooms as embodied in the national and state standards in mathematics and science. They are expanding the meaning of the "basics," putting greater emphasis on even more fundamental skills — questioning, exploring, interpreting, deciding. **Through inquiry's emphasis on learning how to learn, children make a habit of asking questions, exploring possibilities, seeking likely solutions, and making decisions — habits that will equip them for life in a changing world.**

But the very nature of inquiry, with its use of collaborative teaching, learning tools such as the computer and calculator, and hands-on, real-life applications to classroom work, means teachers cannot do it alone. The fact is, if the vision of inquiry learning embedded in the standards is to be truly realized, teachers need support — from their colleagues, from their administration and district, and from parents and community members.

Thus, it is not enough for teachers to enhance their practice through professional development alone. Teachers who believe in inquiry must reach out, sharing the message of the benefits of inquiry-based teaching with others.

Of course, the shift to more inquiry-based teaching is not on teachers' shoulders alone; it will require change at many levels of the educational system. Teachers are, however, uniquely positioned to become prime catalysts for the change that is needed. They know better than anyone how students benefit from inquiry-based teaching of mathematics and science. Teachers also know the challenges they face as they integrate it into their classroom, school, school district and community.

"For most of a child's early years, school is his or her world. What is needed, then, is a better match between the things that are valued in that world and the things that are valued in the world in which the child will function as an adult."

CREATING A CLIMATE FOR CHANGE...MATH LEADS THE WAY

"The challenge before us is large, significant and achievable. It is also too much to place on the shoulders of any one group. Achieving high standards requires the combined, continued support of all Americans."

DR. RODGER BYBEE
EXECUTIVE DIRECTOR, CENTER FOR SCIENCES, MATHEMATICS AND RESEARCH, NATIONAL RESEARCH COUNCIL

Effective Communication: Taking It Beyond the Classroom

Communication is inherent in all good teaching. In fact, the best teachers are known for their ability to reach and engage students in meaningful ways — much of their skill involves good communication practice day in and day out. Yet when it comes to communicating outside the classroom, some teachers feel uncomfortable. Some think it takes some special skills or training to effectively communicate a message to a school board or parent group. Others feel they don't have the time to prepare presentations or other formal communications.

Conversation *n.* The act or instance of talking together, familiar talk or exchange of ideas.

This guide is based on the belief that every teacher can be an effective communicator for standards-based change in mathematics and science by consciously transferring the basic principles of inquiry teaching to their interactions with others — whether those interactions are part of their daily routine or are special activities beyond their regular practice.

"Interpersonal communication influences change. It is only through small group meetings where people have a two-way exchange of information where trust can be built, where in effect they meet eyeball-to-eyeball, that attitudes can be changed."

School Communication Workshop Kit,
National School Public Relations Association

Engaging in conversation about standards-based change can become an integrated part of a teacher's practice — something as simple as sharing ideas over lunch with a colleague or as involved as hosting a parent "inquiry" night or making a presentation to the school board. Viewed this way, what teachers do inside the classroom as they facilitate student learning, and what they do outside the classroom as they build support for the national and state standards, are two sides of the same coin.

This guide is designed to help teachers integrate inquiry communication into their everyday teaching practice, building and broadening the base of support for standards-based teaching of mathematics and science along the way.

Four Stages of Inquiry Communication

The teacher in an inquiry classroom begins not by explaining or defining but rather by learning what the students know or think about the topic. In the same way, inquiry communicators begin by asking questions and listening to what people have to say.

An Invitation

This openness is an invitation to "get in someone else's shoes." Though they may not always agree on everything, most teachers, school administrators, and parents are doing their best to raise and educate children. **Your willingness to listen nonjudgmentally** permits your audience to reveal an attitude, concern or point of view that might not otherwise have been openly expressed.

Exploration and Discovery

Through conversation and dialogue with others, **you can then begin to explore the situation more broadly** and identify the key issues. A colleague may be against inquiry-based teaching because she fears that preparing lesson plans that incorporate an inquiry approach will be extremely time-consuming. Another colleague may feel inquiry invalidates the teaching practice he has followed throughout his career and wonders whether he can make the changes inquiry teaching will require.

Proposing Explanations and Solution

Once you know an audience's key issues, **it's time to consider possible solutions and responses.** For example, if your colleague is anxious about the time commitment involved in inquiry learning, you might consider suggesting ways of gradually moving toward standards-based teaching — something as simple as sharing a lesson plan that has worked well for you.

Taking Action

In the final stage, **you choose from among the workable solutions and take action.** You might start with something simple, such as sending the principal an e-mail with your thoughts about the dynamics of children working in small groups. Or perhaps you'll decide on a broader action, such as telling the school board about your classroom practice.

What Inquiry Communication Is and Is Not

The chart below compares inquiry communications and inquiry-based teaching, along with behaviors inconsistent with both models. As you can see, **inquiry communication is no more complicated than common sense, common courtesy, and respect for others.** But it does require teachers to be as thoughtful and intentional in their communication practice as they are in their teaching practice.

This chart could be used as an overhead or hand out to explain the inquiry approach.

Four Steps to Empathic Communication *adapted from Stephen Covey, 1989.* The Seven Habits of Highly Effective People.	Four Stages of Inquiry-Based Teaching *Adapted from the National Center for Improving Science Education,* The High Stakes of High School Science, *1991.*	Behaviors INCONSISTENT with both models *Adapted from the National Center for Improving Science Education,* The High Stakes of High School Science, *1991.*
• See the problem from the other point of view.	• Invitation – *Ask questions* – *Show interest* – *Leave behind or surface preconceived notions*	• Have preconceived definitions and answers.
• Identify the key issues and concerns involved.	• Exploration, Discovery – *Think freely* – *Form and test new predictions* – *Suspend judgment*	• Dominate the discussion; have only one perspective.
• Determine what results would constitute a fully acceptable solution.	• Proposing Explanations and Solutions – *Explain possible solutions* – *Listen critically to other's explanations*	• Neglect to solicit learners (listeners) explanations for their positions, ideas; look for single solutions.
• Identify possible new options to achieve those results.	• Taking Action – *Apply new labels, definition and knowledge* – *Demonstrate understanding of skill or concept* – *Ask related questions*	• Ignore application to day-to-day living; fail to make realistic recommendations.

How to Use This Guide

Developed with the help of classroom teachers who practice inquiry teaching and are working to integrate it into their schools and school districts, this communications guide has been designed, first and foremost, to be easy to use. Every teacher will have different needs and interests, so it is designed for teachers to easily "pick and choose" from a range of ideas, activities and techniques.

There are four main sections:

- **Starting Conversations** — Inquiry communication in action

  In this section, you'll find three stories of teachers' experiences communicating with three main audiences — teaching colleagues, school administrators and parents. These composite stories, based on situations encountered by Minnesota teachers, are followed by questions to provoke discussion as well as things to do organized according to the four levels of inquiry.

- **Conversation Points** — What do we talk about?

  This section includes the basic messages that can serve as starting points for conversation and presentation. You can refer to this section whenever you need help in how to talk about the need for change, the essence of standards-based improvement and how people can help.

- **Communication Tools**

  This section includes several basic tools that you can adapt for your own purposes. Add to this section as you develop your own tools.

- **Resources**

  This section includes a listing of resources you can draw on in your communications efforts.

"Change comes from small initiatives which work...initiatives which, when imitated, become fashion. We cannot wait for great vision from great people, for they are in short supply at the end of history. It is up to us to light our own small fires in the darkness."

CHARLES HANDY, *THE AGE OF PARADOX*

■

Opening Conversations is a starting point for you to begin building your own plans. So, freely use these pages as your journal and sketchpad.

One Last Thing...

Your efforts at communicating the standards do make a difference. Keep in mind...

Change takes time — lots of it. Systems are conservative by nature, and slow to change. Yet change does happen, step by step. Experts estimate that systemic implementation of the national mathematics and science standards will take 10 to 20 years. Keep the big picture in mind.

"Be impatient enough to take action and patient enough to sustain your efforts until you see results."

NATIONAL COUNCIL OF TEACHERS OF MATHEMATICS

Everything you do counts. Taking the time to explain an inquiry project to a parent may seem an inconsequential act. But change comes one step at a time. Remember — change is a process, not an event.

Celebrate small victories. A compliment from a parent, the support of an administrator, a colleague's interest...these are all milestones on the road to change.

Renew yourself. When frustration at the slowness of change overwhelms you, step back and take a breather. Attend a professional conference. Think about how your students are benefiting from your practice. Keep a log of three encouraging things that happen each week and read it over at the end of the school year — you'll be surprised at your progress!

Build a network of support. Become active in a professional organization. Get connected with a discussion group with other educators on the Internet. Search out the changemakers among your colleagues and cultivate their support. Share ideas regularly with fellow practitioners of standards-based teaching in person, by telephone, or through e-mail.

Inquiry Communication in Action

The following stories of three teachers are composites, based on the experiences of Minnesota teachers as they seek to integrate inquiry teaching of mathematics and science into their classrooms and to build support for their efforts. In each case, the teachers used the principles of inquiry communication to engage those around them. Each story focuses on a key audience:

- **Fellow teachers** Inquiry teaching often involves teachers collaborating within and across disciplines. They work together more closely than they may have done in the past, rethinking teaching objectives, planning classes, and sharing resources. Colleagues who are not yet teaching according to the standards are a key audience for teacher-communicators.
- **Administrators** Teachers who try new approaches in their classroom will need support from their school administration. Without it, they will have difficulty obtaining the resources necessary for planning and carrying out inquiry-based classes. For the majority of teachers, the most significant administrator is the principal in their building, but — depending on the size and structure of the school district — teachers may also need to communicate with the members of the school board, the superintendent, curriculum directors, or site council members.
- **Parents** For many parents, an inquiry classroom is significantly different from the classrooms they remember learning in. Parents often need help understanding these changes and how they benefit the students. When parents become allies, they can serve as influential consumers, lobbying for the time and resources standards-based teaching requires. They also see the importance of encouraging and modeling learning as part of daily life.

Inquiry Communication in Action

Maria: Reaching out to fellow teachers

Sarah: Building a bridge to her principal

John: Encouraging parents to become allies

Following each story are several questions which can be used to stimulate discussion among your colleagues. There is also a list of things to try, organized according to the four levels of inquiry, when you face similar situations. There is space for you to add your own ideas and thoughts.

Maria: Reaching out to fellow teachers

When Maria, a high school mathematics teacher, returned from the SciMath[MN] Teacher Academy, she was the only one in her school's mathematics department using an inquiry-based approach and integrating the national mathematics standards into her practice. While some seemed interested in what she had learned, there was a reluctance among her colleagues to change their teaching practices as she was doing.

A couple said they were convinced that teachers should focus first and foremost on facts and formulas that students need to master before moving on to the more "creative" kinds of work, such as inquiry. Other teachers worried about whether inquiry-based teaching would allow students to complete the required curriculum so they would be prepared for the following year's work. Another common objection was that this "standards business" was probably just another educational fad and those who risk jumping on board would inevitably be disillusioned when trends changed again.

All the teachers expressed concern about scores on standardized tests such as the SAT and ACT exams. Would scores fall if the department incorporated more use of inquiry and began teaching to the standards instead of the tests? How would they explain this to parents anxious to get their children into the best colleges?

Maria knew these were valid concerns, many of which she had thought about as well. Still, she believed so strongly in the concepts embedded in the national mathematics standards that she wanted to share her enthusiasm with her teaching colleagues and build allies among them. In her own quiet way, she began to invite her fellow teachers to learn more about what she was doing.

"Changing attitudes and education practice runs smack up against a host of* Yes, but... *barriers:

- ***our test scores may go down***
- ***some of this isn't even on the state tests***
- ***the other teachers will never change***
- ***we can't afford the technology***
- ***kids who use calculators won't learn the basics***
- ***we just adopted a new textbook***
- ***our administrators won't support us***
- ***our students are different***
- ***parents won't accept the change***
- ***if we just hang on, this too shall pass!***

Many of these* Yes, but... *reactions reflect legitimate concerns. However, important educational problems cannot be resolved by using concerns as a shield against change. We need to find effective ways to get from "Yes, but..." to "But, yes!" and to cope with the fact that change is a necessary and continuing characteristic of education."

Creating a Climate for Change...Math Leads the Way

Informal ways of communicating worked best. Other teachers were often willing to chat about their classes over lunch. Once she invited a colleague to her class to see the students engaged in an inquiry exercise. Another time, at a staff development session after school, she gave a demonstration in which her fellow teachers played the role of students.

Maria also shared resources, making copies of interesting articles, information she had found on the Internet, and conference brochures which she passed along to her colleagues. She signed up for a professional development workshop on the mathematics standards, and invited two interested colleagues to go with her.

The issue of standardized tests was difficult because she couldn't prove that scores would stay the same or increase. But at a staff meeting, she raised the topic of alternative assessments as indicators of what students know and are able to do. A lively discussion ensued in which most everyone shared an idea or opinion. Maria passed around a letter she had written to parents of her students with her thoughts on assessment.

Slowly Maria's ideas gained support. Her own teaching practice was a factor. When other teachers walked by her classroom, they could see that the students were engaged and enthusiastic. The response of Maria's students sparked the interest of several teachers, although one said she worried about what an administrator might think hearing all the chatter going on in Maria's room.

Eventually, Maria and another teacher began to share lesson plans. The department also chose inquiry as the topic for the spring in-service training. "It's a start in the right direction," Maria says.

■

Maria realizes that both she and her colleagues want to do what's right for the students. In her communications with them, she can build on this commonality. By inviting her fellow teachers to observe her class or to play the role of students during a demonstration, she also illustrates good communication skills since "showing" is always more convincing than "telling." Notice that she uses more than one means to communicate: articles, interesting Internet sites, information about professional development opportunities, even statistics about test scores.

SOME QUESTIONS FOR DISCUSSION

1. Maria tries hard to understand the issues behind her colleagues' positions. What issues are most important to your colleagues? How could you find out? What commonalities do you and your colleagues share, despite your different outlooks?
2. If you were helping Maria plan a demonstration for the staff development session, what activity would you suggest and how would you propose she organize the presentation?
3. What do you think Maria used as the main points in her letter on assessment to parents? How would you present these ideas about assessment to your colleagues?

Use this space for your notes. Which steps will you take? When? Put them on your calendar.

Engaging your colleagues: Some things to try

Inviting

Witnessing student enthusiasm first hand can motivate colleagues to consider using inquiry themselves.

- Invite a colleague to stop by your room and observe an inquiry activity in process.
- Invite a colleague to take a look at a particularly interesting resource you've just found on the Internet.
- Invite a colleague to discuss strategies for teaching this week's science unit.
- Share a useful article or e-mail message. Provide copies for your colleagues or post on a central bulletin board — in the teachers' break room or the hallway.
- Use resources — such as buckets of math tiles — as a way of creating interest. Encourage colleagues who ask "What do you do with...?"
- Exhibit student work — not just in the classroom, but in the hallway where everyone can see it. Include a description of the problem that students were trying to solve.
- Invite a colleague to go with you to a workshop, conference or other professional development opportunity.

Exploring and discovering

Many teachers say that this kind of discovery experience is key to building support among colleagues. See p. 67-72 for a listing of resources to assist you in planning activities for teachers' workshops.

- Give your colleague a chance to take the student's role in a demonstration you're presenting at a teachers' workshop.
- After you and a colleague have both presented an inquiry-based lesson, get together for a "debriefing." Talk about what worked and what didn't, and explore ways to change and improve the lesson when you present it again.

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Proposing explanations and solutions

- Work with a colleague to make an existing lesson more inquiry-based.
- Demonstrate the revised lesson with the help of your colleague during a teachers' staff development meeting or site council meeting.
- Stay in touch with your allies — teachers who are supportive of beliefs embodied in the national mathematics and science standards. Make a commitment to meet regularly.

Taking action

- Agree that all grade-level teachers will work together to create one inquiry-based unit per year.
- Establish a staff development team in mathematics and science, either in your building or district-wide.
- Plan a building-wide staff in-service on inquiry-based learning.

SciMath[MN] has developed a 15-minute video that shows how schools are linking inquiry learning in the classroom to the way people learn in homes, workplaces and other everyday places. This video could be shown at a staff in service. See p. 71 in the resource listings for ordering information.

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"All of the science education community — curriculum developers, superintendents, supervisors, policy makers, assessment specialists, scientists, teacher educators — must act to make the vision of these standards a reality."

NATIONAL SCIENCE EDUCATION STANDARDS

Sarah: Building a bridge to her principal

When Sarah and her team returned from the SciMath^MN Teacher Academy, they were excited about the mathematics and science standards and eager to implement inquiry-based teaching. The first thing they did was write a letter to the local school board describing their experience and expressing their enthusiasm for this teaching philosophy.

They expected that the members of the board would acknowledge their commitment, but to their great disappointment, the letter was never answered. They felt their efforts were unappreciated. Months later, they re-read the letter and realized that they had not asked for a response or a chance to make a presentation in person before the school board. Nor had any member of the team followed up the letter with a phone call.

Because the members of the team taught at schools throughout the district, they worked with several different principals. A few teachers found their administration supportive, but others reported that their principals either didn't understand the importance of inquiry-based teaching or were indifferent.

Sarah found that she and her principal had different ideas about styles of teaching and classroom management. His classroom experience had been more teacher-centered, with an emphasis on mastery of what he called "the basics." Because they respected each other as professionals, they agreed to disagree as she told him about her enthusiasm for inquiry learning. Sarah also realized that her principal had a lot of other things on his mind with budget cuts and hiring issues affecting the school.

Remembering her team's unacknowledged letter to the school board, Sarah wondered how to actively engage the interest of her principal and encourage him to help her obtain the resources she needed for her teaching, given the limits on his time and attention.

She decided to invite him to the "egg drop" — an activity in which groups of students test a container they have designed to see if it will prevent an egg from breaking when dropped. He stopped by and the kids loved showing him how to do it. The next day, she shared with him samples of the writing the children had done about the activity in which they analyzed what had happened. (The "egg drop" activity is explained in detail on pp. 162-64 of the National Science Education Standards.)

Several weeks later, she invited the principal to a staff development meeting where she was demonstrating an inquiry-based lesson plan. She asked him ahead of time if he would be willing to join two other teachers who would be playing the role of students. He declined but seemed intrigued by the idea.

Although the principal is still not "a believer," he told Sarah he appreciated her efforts to keep him informed and has tried his best to honor her requests for equipment and extra preparation time.

■

Sarah understands that her principal prefers a more traditional approach. She also understands he may be preoccupied with concerns that have nothing at all to do with her teaching — for example, student discipline, district politics, or staffing considerations. Rather than assuming a lack of interest or active opposition on the part of the principal, she has actively begun to include him. While he may never completely "buy into" the standards and the philosophy of inquiry-based teaching, his response to her efforts has so far been supportive.

SOME QUESTIONS FOR DISCUSSION

1. Rather than automatically assuming hostility or lack of interest on the part of her principal, Sarah has made a genuine effort to understand his point of view. What are some of the issues facing your principal, curriculum coordinator, or school board? If you don't know, how could you find out? How can you present inquiry-based teaching in ways that might relate directly or indirectly to these issues and engage the positive attention of administrators?
2. The principal seemed more interested in observing the "egg drop" than in participating in the teachers' development meeting. What conclusion might Sarah draw from this? How can she use this in her effort to engage the principal in the future?
3. Most people need to hear new information in many different ways and from many different sources before they begin to understand. How can Sarah encourage the principal to learn about inquiry-based teaching from other sources besides herself?

Use this space for your notes. Which steps will you take? When? Put them on your calendar.

Engaging administrators: Some things to try

Inviting

- Invite your principal and school board members to stop by your class to see the students participate in an inquiry-based activity.
- Have students create and deliver a special invitation to the principal or school board members to visit their classroom and observe an inquiry activity. Teachers have found that invitations from students are particularly powerful.
- Write to the members of the school board describing what you have learned at your professional development experience or what your students are doing. Thank them if the district allocated funds for your attendance. Request some time at their next meeting to demonstrate an inquiry-based lesson. Follow up the letter with a phone call.

See a sample letter to the school board on p. 42-43.

- Invite your principal and school board members to attend a professional development workshop with you.

Exploring and discovering

- If the principal does attend a site committee meeting or staff development session where you are demonstrating an inquiry-based lesson, invite him or her to participate along with staff.
- When parents compliment you on inquiry lessons, suggest that they drop a note to the school administrator about how they think their child is benefiting.
- Send a brief memo to the principal with a pertinent newspaper article attached. Put the same article on the bulletin board for everyone else to see.
- Give the principal a copy of this week's "family math problem" or at-home science activity. Ask her if she might have time to try them and share her experiences doing the activities with your students.

See a sample memo on p. 44-45.

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- Create a "Math Matters" or "Science Scenarios" column for the school or parent newsletter. Many teachers have found that, although not directly intended for administrators, this kind of communication has helped principals understand how inquiry-based teaching works.
- When choosing new curriculum materials for an inquiry-based approach, encourage the principal to explore them with you. If this involves a visit to another district, invite him or her to come with you.
- Help the district staff development team present inquiry-based mathematics and science lessons to principals during a district-wide meeting.

See sample parent newsletter articles on p. 50-53.

Proposing explanations and solutions

- Ask the principal to introduce, moderate, or facilitate a presentation on inquiry-based teaching at the next parents' night or open house.
- Invite someone from the local business community to speak to school administrators on the importance of teamwork, critical thinking, and problem solving in today's workplace.

See p. 70 for a listing of materials to help find and invite a local business representative to your school.

Taking action

- If your principal does attend a professional workshop with you, ask if he or she would be willing to help you recreate some part of it for teachers in your building.

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John: Encouraging parents to become allies

A participant in the SciMath[MN] Teacher Academy, John encountered some objections from parents of his fifth-graders after he began using inquiry in his mathematics and science instruction. One objected when John had students working together on inquiry projects. A couple of parents said their children did not appear to be learning "the basics" the way they had when they were in school. Another wondered about the wisdom of their child using a calculator instead of pencil and paper when solving problems in mathematics and science. These same parents expressed concern that homework seemed very different from what they remembered from their own school days.

John listened carefully to these concerns, and invited parents to keep sharing their thoughts and ideas with him. To help parents understand the thinking behind inquiry activities, John sent home several short newsletters explaining the inquiry approach, including suggestions on how to help their child with homework. He hosted a parent night to show how calculators are a valuable learning tool and let parents see first-hand how children use them in the classroom.

During the annual back-to-school night in the fall, John provided an opportunity for parents to work in small groups of three to solve a short problem, employing the same kind of hands-on techniques used by their children. One week in the fall, he invited several parents to talk with the children about their professions and related an inquiry project to some aspect of each parent's work life. One parent became so intrigued by how John incorporated real-life problem-solving that she invited employees at her company to become involved as classroom volunteers, that eventually

"Because the vision of science education is a departure from their own school experience, people outside of science education might find the new vision difficult to accept. However, their understanding and support is essential."

NATIONAL SCIENCE EDUCATION STANDARDS

"If one consistent message can be found in the studies of test score data, whether from the SAT, ACT, NAEP, or international assessments, it is that students perform best when they have taken a challenging program of studies."

NATIONAL STANDARDS IN AMERICAN EDUCATION

See p. 65-66 for a listing of materials that can help you in outreach to parents.

led to a year-round partnership between the business and school. John invited one parent who seemed particularly interested to join him in a presentation to staff on inquiry learning and the mathematics and science standards, and to talk about the parent's point of view.

At parent-teacher conferences, John presented samples of the children's inquiry work and talked about the real-life problems they had solved. He also had students write a few paragraphs on "My Most Interesting Experience This Year," for the fifth-grade newspaper that the class produced twice a year. Several children wrote about an inquiry experience they'd had in mathematics or science. John collected these and shared them with parents, administrators, and others.

■

Because John understands that parents have their child's best interests at heart, he does not take their objections personally. He listens carefully to their concerns and talks with them individually. His periodic newsletter responds to parent concerns. Whenever possible, he shows rather than tells.

SOME QUESTIONS FOR DISCUSSION

1. John realizes that the parents are not against him; they are for their children. How does this help him "market" inquiry-based teaching?
2. John tries to "pull in" interested parents who can then become allies. What are some ways these allies can help John "sell" inquiry to other parents and community members? How can parents become useful supporters and allies for you?
3. Sometimes one parent becomes a "fly in the ointment," complaining to the principal and other parents. How might a teacher handle this in a positive and professional manner?

Use this space for your notes. Which steps will you take? When? Put them on your calendar.

Engaging parents: Some things to try

Inviting

- Send home a list of student activities early in the year so parents can see that group and individual activities are balanced. Explain the ideas that are embedded in the group inquiry lesson.
- Send a letter to parents explaining how inquiry looks in your classroom.

See a sample letter to parents on p. 49.

- Invite parents to come to school and "see what your child is doing." Use student work during conferences to illustrate their children's progress and increased understanding.
- Keep copies of interesting newspaper articles and other pertinent materials to share with parents who stop by or come for back-to-school night or conferences.
- If a video camera is available, take footage of students involved in inquiry-based activities and have students talk on-camera about the role of problem-solving. Show the tape at parent-teacher conferences and open houses, or send it home with students.

A video from SciMath[MN], available to schools, parents and civic groups in 1997, will show inquiry activities in Minnesota classrooms.

Exploring and discovering

- Provide an opportunity for parents to do an inquiry-based group activity during Back-to-School night.
- Provide "family" problems for children and their parents to solve together.
- Create a "Math Matters" or "Science Scenarios" column for the school or parent newsletter. The column could offer tips for parents on how to encourage learning at home, how to apply mathematics and science to everyday life, as well as information about upcoming activities, or sample problems.

See p. 50-53 for sample parent newsletter articles.

- Invite a speaker from the business community to do a presentation for an open house, showcase, or back-to-school night, talking about the importance of incorporating real-life applications in the classroom.
- Allow parents and students to borrow "math bags" or hands-on science kits to use at home.
- Host a "computer night" at school and invite parents to attend, with children demonstrating how they use the computer in their schoolwork.

See p. 67-72 for a listing of materials that can help in planning presentations to parents and others.

Proposing explanations and solutions

- Encourage enthusiastic parents to explain the benefits of inquiry-based learning at PTO or other meetings.
- Encourage parents to talk to other parents about curriculum or teaching.
- Have students write about their experiences and share samples in parent newsletters or other communications.

Remember that attitudes begin to change after people discuss information on an informal basis with friends and associates — individuals they trust.

Taking action

- Ask parents and families to contribute to a collection of "found objects" that can be used in inquiry activities in the classroom. These might include clean milk cartons, plastic tags from bread loaves, plastic pop bottles, various styrofoam containers, card board boxes, etc.
- Involve interested parents in learning more about inquiry and the standards.
- Ask parents to help raise money or solicit donations for purchase of inquiry-oriented materials.

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What Do We Talk About?

Message 1: Navigating in a changing world

Message 2: Developing skills for the 21st century

Message 3: Working together for positive change

The content in this section is based largely on material adapted from sources listed below. We are grateful for their permission for this use.

Parents as Leaders in Science and Mathematics Education Reform: A Source Book for Parents and Community Leaders, National Urban League. Distributed by The Annenberg/CPB Math and Science Collection.

Everybody Counts: A Report to the Nation on the Future of Mathematics Education, National Research Council

Creating a Climate for Change... Math Leads the Way, The Math Connection and WQED/ Pittsburgh. Distributed by The Annenberg/CPB Math and Science Collection.

What Do We Talk About?

Because the activities and learning atmosphere in an inquiry classroom are often different from what most people expect in school, you will undoubtedly encounter many questions from peers, administrators and parents about what you are doing and why. These are opportunities to share your understanding of why inquiry is important.

This section is intended as a resource to help you clearly and simply talk about the inquiry approach and why it makes sense in today's complex world. It suggests ways of describing the context, content and rationale for inquiry and standards-based mathematics and science education.

The three key messages presented here are general themes that you can integrate into your explanations and presentations; on the following pages, each message is expanded with supporting points. Consider the messages as raw material to draw on for fashioning your communications.

The three messages are presented sequentially and build on each other. Used together, the messages can help people consider the broader context in which education exists and help them understand why education, like other institutions in society, must change and adjust in order to be useful and relevant.

Message 1

Mathematics and science education is important for all children.

Navigating in a changing world

Understanding mathematics and science gives us the power to take control of our lives in a complex and changing world. Everyone deserves and needs this understanding.

Message 2

We need to change the way mathematics and science are taught.

Developing skills for the 21st century

All children can understand mathematics and science more readily when these subjects involve hands-on activities that are linked to a child's experiences, and that challenge them to make connections between new and previous learning.

Message 3

We all have a role in improving education for all children.

Working together for positive change

Each in our own way, we all need to become part of the learning community. The involvement of parents, businesses and other community members in the education of all children is critical for everyone.

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"Why is science literacy important? First, an understanding of science offers personal fulfillment and excitement... Second, Americans are confronted increasingly with questions in their lives that require scientific information and scientific ways of thinking for informed decision making. And the collective judgment of our people will determine how we manage resources — such as air, water and national forests.

Science understanding and ability also will enhance the capability of all students to hold meaningful and productive jobs in the future. The business community needs entry-level workers with the ability to learn, reason, think creatively, make decisions, and solve problems. In addition, concerns regarding economic competitiveness stress the central importance of science and math education that will allow us to keep pace with our global competitors."

NATIONAL SCIENCE EDUCATION STANDARDS

Message 1 — Navigating in a changing world

Mathematics and science education is important for all children. Understanding mathematics and science gives us the power to take control of our lives.

- **It gives us access to jobs.** We all want children to be prepared for employment in their chosen fields. Many good jobs require a knowledge of science and mathematics. Employers and managers in the workplace of tomorrow want workers at all levels who can solve problems, who can learn new skills on the jobs, and who have a basic understanding of science, mathematics and technology.
- **We can help the economy of our nation.** We need well-prepared citizens who will be our future scientists, mathematicians and engineers to keep our country creative and competitive. We will also need teachers of these subjects to prepare the next generation. And we will need people who work in many other areas who are scientifically and mathematically literate — who ask questions, solve problems and find solutions.

  Young or old, we all benefit when citizens are well-prepared to enter the workforce. In an age when more people are living longer, there will be greater needs for healthcare workers. With the growth of fields such as biotechnology and genetics, we will need skilled problem-solvers. With the rapidly expanding computer and communications systems, there will be a need for many more mathematically and scientifically literate workers. And we will always need people who can learn new skills for jobs that will change and be created in the future.

- **We can meet the challenges of development in our communities.** Many of our communities need more housing and new infrastructure to move people, goods, water and waste, and to allow for modern means of communication. We need carpenters, electricians, plumbers, and technicians. We need new housing designs that create better living situations. Young people can use science and mathematics to prepare themselves to meet the challenges of development in their communities.
- **We can make difficult decisions sensibly and wisely.** Many personal and community issues are rooted in science and mathematics. For example, how can an individual avoid diseases such as AIDS or tuberculosis and how can a community keep all its members healthy? How can someone on a tight budget reduce expenses by saving energy at home or how can a community save energy and reduce costs for all its taxpayers? How can understanding statistics and developing number sense keep a person from being misled by false advertising? Information and knowledge empower a person. The more a person knows about mathematics and science, the more empowered he or she will be.
- **We can understand and appreciate the world we inhabit.** Children, young and old, take pleasure in knowing and understanding the natural world. People delight in finding patterns in nature that make things predictable and in seeing that nature can be fragile and mighty, simple and complex. Understanding how this amazing and interconnected world works — and our place in it — opens doors to appreciating it on many levels.

"Communication has created a world economy in which working smarter is more important than merely working harder. Jobs that contribute to this world economy require workers who are mentally fit — workers who are prepared to absorb new ideas, to adapt to change, to cope with ambiguity, to perceive patterns, and to solve unconventional problems."

Everybody Counts: A Report to the Nation on the Future of Mathematics Education

SOME QUESTIONS FOR DISCUSSION

1. How do you use mathematics and science content and/or skills in your job, in everyday life?
2. Talk with employers in your area. What skills are they looking for in employees? How can these be cultivated at home and in school?
3. How has your job, profession or industry changed due to technology or other developments?

"More is expected of our teaching force than ever before. Successful efforts to restructure schools for the demands of a knowledge-based economy depend critically on the nation's teachers."

INTERSTATE NEW TEACHER ASSESSMENT AND SUPPORT CONSORTIUM, 1995

Message 2 — Developing skills for the 21st century

We need to change the way mathematics and science are taught so that children will be equipped for the 21st century. All children can understand mathematics and science more readily when these subjects involve challenging activities that are linked to personal experiences and that build on past learning.

Why do we need to change the way children of all ages learn science and mathematics?

- Classroom practice does not prepare students well enough for full participation in the world outside its doors.

  — Curriculum is too reliant on memorizing facts without opportunities for "hands-on," problem-solving experiences that makes learning meaningful. Thus, students are not developing the critical thinking skills sought by employers.

  — In many classrooms, students learn science and mathematics while sitting at desks working by themselves. Without group learning, they are deprived of the opportunities to learn from their peers, to teach someone else and to work together in teams.

  — Students are asked to cover so much material so fast that they run the risk of not learning anything at all. When they do have "hands-on" classes, the "minds-on" part may be missing, that is, the opportunity to provide explanations and interpretations of observations and experiences that reflect understanding.

- Our expectations for student achievement and for performance in science and mathematics are too low.

  — When science is not required or given only cursory attention, students know it is not valued.

— When girls from all groups and boys who are African American or Hispanic are discouraged from taking the physical sciences, algebra or advanced science and mathematics courses, our expectations are too low.

— Teachers, guidance counselors, parents and public opinion are all responsible for encouraging students to learn mathematics and science, and this encouragement is not happening often enough.

"All students, regardless of age, sex, cultural, or ethnic background, disabilities, aspirations, or interest and motivation in science...should have the opportunity to...develop the knowledge and skills described in the Standards, even as some students go well beyond these levels."

NATIONAL SCIENCE EDUCATION STANDARDS

- Too many students drop out of science and mathematics and thus are being shut off from the possibilities of a better future.

— By the time they complete school, very few students are scientifically and mathematically literate. Very few are prepared to successfully study science and mathematics in college or technical school, or have the mathematics and science skills required for the workplace.

— Most U.S. students lose their interest in science as they approach the middle grades, even though most of them liked science in elementary school. Only about half of high school students take chemistry, and only one student in five takes physics. Girls, minorities, and other teenagers who do not plan to attend college are even less likely to take these courses.

— While mathematics is considered among the core subjects taught in schools, many girls and students of color are not encouraged or expected to take algebra and advanced mathematics classes. The adults in their lives may not believe these youth can succeed in science and mathematics and may steer them elsewhere. Or they may not understand how critically important science and mathematics education are to prepare all children for the future.

"It is no wonder that many students stop studying mathematics as soon as it becomes optional, since society provides so few hero-images for whom perseverance in mathematics has paid off. 'Hard work pays off' should be society's message to those who study mathematics."

EVERYBODY COUNTS: A REPORT TO THE NATION ON THE FUTURE OF MATHEMATICS EDUCATION

This chart may be helpful to explain the change going on. Photocopy and use as a hand-out.

What is the shift in teaching that will help ALL children learn mathematics and science?

There is less emphasis on...	And more emphasis on...
• whole-class, teacher-directed instruction	• experiential, inductive, hands-on learning
• students receiving and absorbing information by sitting, listening and notetaking	• active learning in the classroom, with students doing, talking and collaborating
• teachers valuing and rewarding silence in the classroom	• teachers listening, questioning and clarifying
• classroom time devoted to 'seatwork': workbooks, worksheets, dittos, etc.	• open-ended problem-solving
• superficially covering large amounts of content material	• deep, integrated study of a smaller number of significant topics
• rote memorization of facts and details	• higher-order thinking of a discipline's key concepts and principles
• tracking students in ability groups	• heterogeneously grouped classrooms where individual needs are met through inherently individualized activities
• use of and reliance on standardized tests	• multiple assessment tools, such as teachers' descriptive evaluation of student growth, including anecdotal observations
• competition and grading	• cooperative, collaborative activity; developing the classroom as an interdependent community

Summary of common recommendations of the national curriculum reports, national mathematics and science standards.

How can we bring about this shift in teaching for our children?

In an effort to align our children's mathematics and science education with the reality of a changing world, the mathematics and science communities have developed national voluntary education standards that reflect a new vision of how mathematics and science can be taught so that all children will achieve at higher levels. These standards reflect national consensus among science and mathematics educators about the best ways to achieve that vision.

The standards describe not only content, but also the exemplary teaching practices that provide students with inquiry-based experiences that enable them to achieve mathematical and scientific literacy, the criteria for assessing and analyzing student achievement in science and mathematics, and the learning opportunities that should be available in school science and mathematics programs.

The Minnesota Graduation Standards are aligned with the national standards, which set forth the core concept of inquiry-based learning and teaching.

The Minnesota K-12 Science and Mathematics Curriculum Frameworks are tools for bridging national mathematics and science standards to the Minnesota Graduation Standards and classroom practice. Available from SciMath[MN] in Spring 1997. See p. 55 for ordering information.

How do the standards address students who have traditionally not been encouraged to achieve in mathematics and science?

The national voluntary education standards apply to all students no matter what their age, gender, cultural or ethnic background, disability, aspirations, or interest and motivation. While the present system essentially gives up on under-achieving students by holding lower expectations for them — then holding them to lower standards — the standards establish high expectations and standards for **all** students. The standards also help teachers to select a curriculum and the means of instruction that will enable disadvantaged students to meet the standards. The level to which each student achieves understanding will vary, but core content should be included in every student's program.

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"The purpose of inquiry is to help learners increase their competence as learners."

TEACHING AS A SUBVERSIVE ACTIVITY,
NEIL POSTMAN/CHARLES WEINGARTNER

What is meant by inquiry?

Inquiry is an approach to learning that involves making observations, posing questions, examining books and other sources of information to see what is already known, planning investigations, using tools to gather, analyze and interpret data, proposing answers, explanations and predictions, communicating the results, and raising new questions.

Through inquiry, students establish connections between their current knowledge of science and mathematics and the knowledge found in many sources; they apply science and mathematics content to new questions; they engage in problem-solving, planning, decision making, and group discussions; and they experience assessments that are consistent with an active approach to learning.

Because inquiry emphasizes learning how to learn, children make a habit of asking questions, exploring possibilities, seeking likely solutions, and making decisions, habits that will equip them for life in a changing world.

SciMath[MN] has produced an inquiry video which includes the testimonials of parents, businesses, teachers and students who learn by questioning everyday. See p. 71 in the resource listings for ordering information.

How will the standards influence how teachers are prepared to teach science and mathematics?

The national standards call for substantive changes both in the way science and mathematics are taught and in the way teachers are educated in colleges and universities. Effective science and mathematics teaching requires pedagogical content knowledge, which is a special understanding that allows integration of content, curriculum, learning theories, teaching practice, and knowledge of student needs. Preservice and professional development activities must model good standards-based teaching. Ongoing, effective professional development must become central in teachers' lives.

Nearly 500 Minnesota educators from K-12 and higher education institutions are involved in transforming the teacher education programs at Minnesota's post-secondary institutions to bring them into alignment with national and state standards-based reform efforts. SciMath[MN] and Minnesota educators have produced a document, *Transforming Teacher Education: A Minnesota Framework for Mathematics and Science*, to assist in this alignment. See p. 72 for ordering information.

How will standards-based teaching change the way students are tested? Or will teachers just be "teaching to a different test"?

Tests will rely more heavily on open-ended questions. Teaching the skills necessary to solve these problems will be more like "teaching to real life." These will be tests of real problem-solving skills, not simply memorization or test-taking strategies for multiple-choice exams. Questions will be open-ended and often there will be several right answers. It will be important for students to explain the choices that they make and show the process used to get the answer.

What is the difference between today's standards and reforms of the past?

- Past reforms dealt primarily with content and curricula. The national standards reflect a growing understanding that all elements of the education system must come together for any reform to succeed.
- Past reforms were often led by one segment of the community. The call for standards now comes from business, industry, educators, policy makers and society as a whole.
- Past reforms were based on the assumption that some people can do mathematics and science, and some can't. **Standards assume that everyone can and must be scientifically and mathematically literate.**
- Past reforms focused on producing a few leading scientists and mathematicians, while today we understand that scientific and mathematical literacy for **all** is a key to our country's success.

KEY IDEAS IN MATHEMATICS AND SCIENCE STANDARDS

■ **Everyone can and must learn more mathematics and science.**
Reform should enable learners to understand and use mathematics and science at higher levels and to think mathematically and scientifically.

■ **Understanding mathematics and science is more important than just covering content.**
Education should focus on ideas and skills that constitute scientific and/or mathematical literacy and emphasize understanding over coverage of material.

■ **Learning is doing.**
People learn in the course of meaningful activity, a process different from mastering concepts and procedures or memorizing facts. Both are valuable because they help people understand and participate in the world around them.

■ **Mathematics, science and technology are interdependent.**
Curricula and instruction should reflect the interrelationship of mathematics, science and technology knowledge and challenge traditional subject boundaries.

■ **Human knowledge has a history and a context.**
People learn mathematics and science by building on past experience and what others have done. People learn and work as part of a community, not alone.

From Math and Science Standards: A Policymaker's Primer

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"Good science and math education moves away from passive, unchallenging learning toward active, mentally challenging learning."

PARENTS AS LEADERS IN SCIENCE AND MATHEMATICS EDUCATION REFORM: A SOURCEBOOK FOR PARENTS AND COMMUNITY LEADERS

THREE KINDS OF LEARNING

***Rote*: Memorization or repetition carried out with little depth or understanding.**

***Hands-on:* Active learning in which students use materials to make things or model concepts.**

***Minds-on:* Critical thinking skills developed through the processes of designing, comparing, and drawing conclusions. Indicators that students are thinking deeply about their learning include when they ask, "What if," "How come," and "Can we try it another way" questions after a learning activity.**

PARENTS AS LEADERS IN SCIENCE AND MATHEMATICS EDUCATION REFORM: A SOURCEBOOK FOR PARENTS AND COMMUNITY LEADERS

Won't the emphasis on working in groups hold back some students and subject others to ridicule?

Research has shown that students learn better in mixed ability groups. Structured group work challenges **all** students to excel and learn. All students benefit from having to clarify and communicate their thinking with each other. Working in groups also helps students prepare for the workplace since business and industry depends heavily on the work of teams.

What about the use of calculators and computers in the classroom?

Polls show that the public generally thinks that, in mathematics education, calculators are bad while computers are good. People tend to believe that calculators will prevent children from mastering arithmetic, an important burden which their parents remember bearing with courage and pride. Computers, on the other hand, are not perceived as shortcuts to undermine school traditions, but as new tools necessary to society that children who understand mathematics must learn to use. What must be recognized is that calculators and computers are both essential to mathematics and science education and have equal potential for wise use or for abuse.

Calculators and computers compel reexamination of priorities for mathematics and science education. How many adults, whether store clerks or bookkeepers, still do long division with pencil and paper? How many scientists or engineers use paper-and-pencil methods or slide rules to carry out their scientific calculations? Who would trust a bank that kept its records in ledgerbooks?

Society has much to gain from the increasing role of calculators and computers in mathematics and science education:

- School mathematics and science programs can become more like the mathematics and science people actually use, both on the job and in scientific applications. By using machines to expedite calculations, students can experience mathematics and science as they really are — as exploratory disciplines in which risks and failures yield clues to success.
- Calculators in the classroom can make higher mathematics and science more accessible. For example, weakness in algebraic skills need no longer prevent students from understanding ideas in more advanced mathematics classes. Just as computerized spelling checkers permit writers to express ideas without the psychological block of terrible spelling, so will calculators enable motivated students who are weak in algebra or trigonometry to persevere in calculus or statistics.
- Mathematics and science learning can become more active and dynamic, and thus more effective. By carrying much of the computational burden of homework, calculators and computers enable students to explore a wider variety of examples; to witness the dynamic nature of mathematical and scientific processes; to engage realistic applications using typical data; and to focus on important concepts rather than routine calculation.
- Students can explore mathematics and science on their own, to ask and answer countless "what if" questions. Although calculators and computers will not necessarily cause students to think for themselves, they can provide an environment in which student-generated mathematical and scientific ideas can thrive.
- Time invested in mathematics and science study can build long-lasting intuition and insight, not just short-lived strategies for calculation.

SOME QUESTIONS FOR DISCUSSION

1. What was your personal experience of school mathematics and science education?
2. Did your parents expect you to do well in mathematics and science? If not, why didn't they? What messages are sent to children that might discourage them from continuing in mathematics and science throughout their education?
3. How do you think students will respond to the shift in teaching described in the chart on page 28?

The following pages present a summary overview of the national voluntary education standards in mathematics and science.

These summaries might serve as a useful hand-out. Copy and distribute as needed.

National Mathematics Education Standards

Released in 1989, the National Standards in Mathematics Education were developed by the National Council of Teachers of Mathematics.

Founding principles...

- The goal of teaching mathematics is to help all students develop mathematical power. All students can learn to think mathematically.
- "Knowing" mathematics is "doing" mathematics, not memorizing mathematics.
- How well students come to understand mathematical ideas is far more important than how many skills they acquire.
- Teaching is a complex practice and cannot be reduced to recipes or prescriptions.

Students will...

- learn to value mathematics
- become confident in their ability to do mathematics
- become mathematical problem solvers
- communicate and reason mathematically

Teachers will...

- pose tasks that are based on sound and significant mathematics
- pose questions that elicit, engage and challenge each student's thinking
- use concrete materials to move students toward conceptual understanding
- facilitate student reflection, reasoning and communicating about mathematics
- incorporate calculators, computers and other technologies
- embed assessment in instructional activities

Administrators will...

- support a climate of change
- promote excellence in mathematics teaching and learning
- provide adequate resources, equipment, time and funding
- provide opportunities for teacher collaboration
- align assessment to curriculum goals
- establish outreach activities with parents and business/community partners to effectively communicate and build support for quality programs

Curriculum will...

- include a broad range of content
- actively engage children in doing mathematics
- grow out of problem situations and emphasize the application of mathematics

National Science Education Standards

Released in 1995, the National Science Education Standards were developed by the National Research Council.

Founding principles...

- Science is for all students.
- Learning science is an active process.
- School science reflects traditions of contemporary science.
- Improving science education is part of systemic education reform.

Through their study of science, students will...

- experience the richness and excitement of the natural world
- apply scientific principles and processes to make personal decisions
- intelligently discuss matters of scientific and technological concern
- increase their economic productivity

Teaching standards focus on what teachers do and describe knowledge and skills that are the foundation of science teaching:

- plan inquiry-based science programs • guide and facilitate learning
- assess teaching and learning • develop science learning environments
- create science learning communities • actively participate in ongoing planning

Professional development standards outline criteria for pre-service and inservice professional development including:

- learning science content • learning to teach science
- life-long learning • professional development programs

Assessment standards guide in developing assessment practices and policy by:

- coordinating assessments with purposes • avoiding bias
- making sound inferences • measuring achievement and opportunity
- matching technical quality of data with consequences

Content standards broaden the scope of science content beyond traditional concepts:

- science as inquiry • physical science • life science • earth and space science
- science and technology • science in personal and social perspectives
- history and nature of science • unifying concepts and processes

Science program standards focus on school and district opportunities for students and teachers:

- consistency with and across K-12 • effective curriculum
- science coordinated with mathematics • resources • equity and excellence
- schools as communities of learners

Science system standards specify the support systems and resources needed to provide all students the opportunity to learn science:

- common vision • individual responsibility • continuity over time • resources
- equity • coordination within and across the system • unanticipated effects

Message 3 — Working together for positive change

We all have a role in improving education for all children. The involvement of parents, businesses and other community members in the education of all children is critical. Real change requires action by everyone who has a stake in our children's future.

"The answer to the question, 'Can we change?' is 'We must!' For parents, community leaders, policy makers, and teachers, that means changing:

- *what we expect all students to know and be able to do*
- *how we measure what all students must know and be able to do*
- *how we teach what all students must know and be able to do*
- *the tools we use for teaching and learning..."*

Creating a Climate for Change... Math Leads the Way

What can students do?

- Study mathematics and science every school year.
- Discover that mathematics and science are all around us.
- Use mathematics and science in other classes and in daily life.
- Study a broad variety of mathematical and scientific subjects.
- Encourage each other; form study groups for learning and support.

What can teachers do?

- Engage students actively in the process of learning.
- Talk with each other about mathematics and science teaching practices.
- Examine current practice and debate new proposals.
- Participate in professional development programs related to mathematics and science teaching and learning.
- Prepare a personal professional development plan covering a period of at least 3 years.
- Join professional teaching organizations and read their journals in a timely fashion.
- Use video and print materials to acquaint parents and colleagues with some of the fundamental ideas about change in mathematics and science education.

An excellent way to stay connected to the science and mathematics communities in Minnesota is to join the teaching professional organizations: Minnesota Science Teachers Association (MSTA) and Minnesota Council of Teachers of Mathematics (MCTM). See p. 70 for contact information.

What can parents do?

- Value education. Value mathematics and science.
- Encourage schools to implement the national voluntary mathematics and science standards.
- Encourage children to continue studying mathematics and science.
- Be certain the messages you send your children about mathematics and science are positive and practical. Show how you use mathematics and science at work and home.
- Don't repeat old myths that will hold your children back from achieving all they can: "Boys are better than girls in mathematics and science." "You only need mathematics if you are going to be a scientist." "You are either good at mathematics or you aren't." "I wasn't good at mathematics, so you probably won't be either. And that's OK."
- Support teachers who seek standards-based improvements and use inquiry. Lobby to ensure your school has access to calculators, computers and "hands on" materials.
- Use the school newsletter to encourage other parents to also get involved in providing their children with a 21st century approach to mathematics and science.
- Expect mathematics homework to be more than routine computation and science homework to be more than memorization of facts, formulas and vocabulary.

What can school administrators do?

- Become educated on issues in mathematics and science education.
- Provide time and opportunities for teachers to work together.
- Promote staff discussion on the national and state standards.
- Encourage, praise and reward teachers who invest in professional development, who introduce new content and employ new teaching methods based on the national and state standards.

"Parents are a child's first teacher...and they are probably the most important teacher their children will ever have."

AMERICAN FEDERATION OF TEACHERS

These tips for parents could be used as content for a newsletter article or letter sent home.

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"No one group can implement the Standards. The challenge extends to everyone within the educational system...It also extends to all those outside the system who have an influence on science education, including students, parents, scientists, engineers, businesspeople, taxpayers, legislators and other public officials. All of these individuals have unique and complementary roles to play in improving the education that we provide to our children..."

NATIONAL SCIENCE EDUCATION STANDARDS

What can superintendents do?

- Stimulate public discussion of mathematics and science education.
- Have staff prepare a plan to bring the district's programs into alignment with the national voluntary mathematics and science education standards and the Minnesota Graduation Standards.
- Support teachers and principals in the development of a continuous program of professional development in standards-based instruction.
- Establish a plan to provide, maintain and periodically update classroom technology that will prepare students for their future.
- Encourage and provide resources for classroom innovation.
- Support a climate of change.

What can school boards do?

- Become informed about the overall vision and principle goals of the national voluntary education standards in mathematics and science.
- Assess how well the current mathematics and science programs are aligned with the national voluntary education standards and Minnesota Graduation Standards.
- Support innovation and professional development.
- Support a climate of change.

See p. 42-43 for tips on communicating with your local school board.

What can business and industry do?

- Encourage students to study mathematics and science.
- Learn about the national voluntary education standards in mathematics and science and the Minnesota Graduation Standards.
- Support local efforts to secure funds for education.
- Seek out opportunities to partner with local schools.
- Volunteer to show teachers and students how mathematics and science are used in your business to solve real problems.
- Become familiar with the concerns of local teachers.
- Provide internship opportunities for teachers.
- Provide opportunities for employees to learn about changes being proposed in mathematics and science education and to consider how they might support those changes in working with their children or in working with the schools.
- Align corporate educational outreach, charitable giving, and employee volunteerism with goals of standards-based change.

"The national science and mathematics standards provide business with a rudder that can direct all of our efforts in support of math and science education, no matter at what level we are involved. For example, a business that wants to make contributions to schools can use the Standards as a guide to funding decisions...Similarly, a business that wants to get employees involved in education can involve them in projects of school districts, such as curriculum writing projects that are standards-based...Businesses could celebrate the wonderful successes of school, highlighting exemplary implementation of the Standards...Finally, businesses can educate their employees about the Standards and help them become knowledgeable consumers of education."

PENNY HUNT, DIRECTOR OF COMMUNITY AFFAIRS AND MEDTRONIC FOUNDATION, MEDTRONIC, INC.
From "Breaking Common Ground: In the process of discovery," a report on the SciMath[MN] 1996 Assembly.

SOME QUESTIONS FOR DISCUSSION

1. What are some examples of how the community (business, industry, government) interacts with your school?
2. What are some of the challenges of involving business people and other community members in classroom activities?
3. What are the benefits businesses receive from working as partners with schools and teachers?

Letter to school board

Memos to administrators

News release

Letter to parents

Parent newsletter articles and hand-outs

Developing a Communications "Toolkit"

Sometimes you will need to use a communications tool when face-to-face communication is not feasible. This section presents samples of tools that educators can adapt to their own use, along with tips for using them most effectively.

It's important to remember that written communications are no substitute for personal interaction and conversation with others. However, a well-prepared letter or memo can open the door for interest and inquiry from someone you would like to engage in conversation.

Similarly, submitting a news release to a local newspaper can be an effective way of letting your local media know of the improvements you are working on, which may lead to their interest in developing articles and covering your progress. If used by the news outlet, a news release can be one means to raise awareness in the community. However, research shows that mass communications — newspaper, radio and television — do not change attitudes.

"A group gains awareness and knowledge about ideas from the mass media, but doesn't adopt and use new ideas until influenced by leaders in the group, friends and family."

JACK PYLE, BUILDING COMMUNITY SUPPORT FOR SCHOOLS

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Use this space to jot down some ideas you would like to share with members of your local school board.

Letter to school board

Teachers returning from the SciMath[MN] Academy or other professional development experiences want to let their school board (or administrators) know more about what they did at the Academy and how what they learned will enrich their teaching. A first step might be an explanatory letter.

Tips

- Make your letter direct and to the point.
- Mention the project your team worked on with your business partner. School board members are often business and professional people. They may find the "real world" application of science and mathematics intriguing.
- Make a request. Do you want to make a presentation at the next school board meeting? Have individual team members meet with school board members one-on-one? Invite school board members to observe a class or participate in a back-to-school night? Whatever it is, ask for it.
- Follow up your letter with a phone call.

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SAMPLE LETTER TO SCHOOL BOARD

September 9, 1996

Mr. William E. Peters, President
Lake Ohmygosh School Board
1234 East County Road 37
Lake Ohmygosh, MN 55678

Dear Mr. Peters:

This summer four teachers from Lake Ohmygosh Elementary School and their principal attended the SciMath^{MN} Teacher Academy, a two-week professional development experience held in June at [location]. The team from Lake Ohmygosh was among 19 teams representing school districts around the state.

The five of us — teachers Jane Smith, Lori Chang, Jack Green, and Ramon Garcia and principal Maria Hughes — had a chance to experience how inquiry-based learning can be applied to elementary math and science classes, based on the national voluntary standards in mathematics and science and the Minnesota Graduation Standards.

These standards emphasize development of higher-order thinking skills and open-ended problem-solving, skills fostered through teaching practices that include inquiry activities. In inquiry activities, children ask questions, explore possibilities, seek likely solutions, and make decisions, habits that will equip them for their future.

At the Academy, teams are paired with business partners with whom they work to solve actual workplace problems. Our team collaborated with engineers from [company name] on the development of a wind tunnel to test how a new type of helicopter will stand up to resistance.

All five of us returned from the Academy eager to begin applying inquiry-teaching in our classrooms. We want to share some of what we learned this summer with the Lake Ohmygosh School Board. At an upcoming meeting of the board, we'd like to present a brief video that shows how an inquiry-based classroom works and do a simple hands-on activity with the members of the board playing the role of students.

I will call you early next week to arrange for our team presentation to be placed on the agenda of an upcoming school board meeting.

We look forward meeting with you soon.

Sincerely,

Lori Chang

Here you can begin to sketch out a plan for communicating with your administrator. Set a timeline for yourself, but remember that even small steps are significant over the long process of change.

Memos to administrators

Tips

- Keep memos short and to the point.
- Limit your memo to one subject.
- Invite the administrator to take action. Do you want the principal to call a parent? discuss an article with you? approve your request for equipment? Be explicit about what action you would like him or her to take.
- Follow up in a couple days. Ask if he or she has had a chance to read your memo and whether you can get together for a few minutes to discuss it.

SAMPLE MEMOS

MEMO

Date: May 17, 1996

To: Mr. Cook

From: Ms. Smith

Re: FYI: parent reaction

At last night's parent-teacher conferences I met with Mrs. Jones, the mother of Johnny. As you know, Mrs. Jones has been skeptical about the use of inquiry in fifth grade mathematics and vocal in her concerns that students weren't learning "the basics."

Last night, however, she told me that she feels Johnny is understanding mathematics better than he ever has. Not only that, but he now shows some enthusiasm for a subject he used to hate.

She says she would be willing to talk with you about her "change of heart." If you'd like to call her, the number is 987-6543.

MEMO

Date: February 20, 1996

To: Mr. Cook

From: Ms. Smith

Re: FYI: interesting article on teams in the workplace

I'm attaching an article that appeared in the business section of yesterday's Star Tribune. It underscores the importance of teamwork in today's workplace and points out that tomorrow's work environment will continue to be collaborative.

Sounds a lot like what we're trying to do in our inquiry-based science units this year.

After you've had a chance to read the article, I'd welcome a chance to discuss it with you over a cup of coffee.

News release

Teams from smaller school districts might want to send a press release to the local weekly newspaper about their SciMath[MN] involvement, other professional development experiences or the change being made in the science/mathematics curriculum. Other subjects for a news release might be tips for parents to enhance their children's interest and skills in mathematics and science or to describe business-school partnerships or other innovative programs. In large urban districts, a release could be sent to the community newspaper that covers the school's local neighborhood; your district may have a public relations staff person who is familiar with local media and can assist you in submitting an article or in having it placed in school district communications.

Tips

- Send a news release when something will or has happened that may be of interest to a wide cross section of the community.
- Call the editor first. Tell him or her you would like to submit an article and ask for any tips or advice about what the paper would find of most interest.
- Ask the deadline for the next issue. Submit your release on time.
- Keep your news release short and to the point. Avoid education jargon. Use "plain English."
- Provide the name and telephone number of a contact person.
- Double space your news release.
- Date your release.
- Use quotes AND concrete examples.
- Follow up your release with a telephone call to the editor. Be prepared to offer interview suggestions and photo opportunities. (Check on district policies first).
- Keep a copy of the release: editors have a tendency to mislay news releases and may request that you send or fax them another copy.

A resource on media relations is the *Communications Handbook of the National Council of Teachers of Mathematics*. It includes sections on media outreach, print broadcast, speeches and presentations and public forums.

To order call toll-free 1-800-235-7566, or write National Council of Teachers of Mathematics (NCTM), 1906 Association Drive, Reston, VA 22091-1593.

SAMPLE NEWS RELEASE

FOR IMMEDIATE RELEASE:
September 5, 1996

FOR MORE INFORMATION
Jane Smith, 321-4567

Lake Ohmygosh team returns from SciMath^{MN} Teacher Academy with new ideas and enthusiasm

Lake Ohmygosh Elementary School science and mathematics teachers started classes this fall with heightened enthusiasm for their subject matter and plenty of new teaching strategies to engage their students.

Teachers Jane Smith, Lori Chang, Jack Green, and Ramon Garcia and principal Maria Hughes attended this year's SciMath^{MN} Teacher Academy, a two-week professional development experience held in June at [location]. The team from Lake Ohmygosh was among 19 teams representing school districts around the state who experienced how inquiry-based learning can be applied to elementary mathematics and science classes, based on the national voluntary standards in mathematics and science and the Minnesota Graduation Standards.

These standards emphasize development of higher-order thinking skills and open-ended problem-solving, skills fostered through teaching practices that include inquiry activities. In inquiry activities, students ask questions, explore possibilities, seek likely solutions, and make decisions, habits that will equip them for their future.

Inaugurated in 1994, the SciMath^{MN} Teacher Academy uses the processes inquiry and real-life problem solving to help teachers develop tools and techniques they can uses in their classrooms. Teams are paired with business partners with whom they work during the Academy to solve actual workplace problems. Lake Ohmygosh teachers collaborated with engineers from ABC Company during the Academy.

Third grade teacher Kent Jones says the team experience has given teachers "a common ground. We talk about what we've learned and our ideas of how to apply it in our classes. We get solid support and practical help from each other."

Fifth grade teacher Mary Lewis says she's looking forward to "incorporating relevant, hands-on activities that will lead children to a better understanding of basic mathematics and science concepts. The connections young children can make are phenomenal. This approach will help them make many more connections between what they learn in school and the world of work."

Lake Ohmygosh School has 350 students in kindergarten through sixth grade.

--end--

Parent communications

Written communications from teachers to parents about mathematics and science can heighten parent awareness and build their understanding of what their children are doing in the classroom. Included in this section are several samples that can be adapted for your own purposes:

See p. 49 for a sample letter to parents.

- **Letter to parents**: A letter can be sent home at the beginning of the year will help parents understand the methods and activities being used in your classroom. The letter also suggests ways they can help their children at home. Adapt it to your situation and teaching practice.
- **Newsletter articles:** Articles can be included in a class newsletter or a school newsletter sent home periodically to all families. These articles encourage parents to engage their children in inquiry-type activities at home that involve mathematics and science.

An excellent source of additional informational hand-outs for parents is *Parents as Leaders in Science and Mathematics Education Reform, A Sourcebook for Parent and Community Leaders.* Topics of hand-outs include: Science and Math at Home for Young Children; Science and Math at Home for Ages Six to Ten; Science and Math at Home for Middle Schoolers; Science and Math at Home for Teenagers; Characteristics of Good Science Programs; Homework is Part of Science and Math Success; Learning Science and Math in Your Community; Building a Strong Parent/School Relationship; Science and Math Are for Girls; Math Opens Doors... And It's Fun Too!.

For copies of the Sourcebook and outreach kit in English or Spanish, contact:

The Annenberg/CPB Math and Science Collection
P.O. Box 2345
S. Burlington, VT 05407-2345
1-800-965-7373
http://www.learner.org/k12

SAMPLE LETTER TO PARENTS

Dear Parents:

I'd like to tell you about some aspects of how your child will be learning mathematics and science in our classroom this year, ways that are designed to engage young learners and improve their understanding and achievement in mathematics and science.

Mathematics

- Because mathematics is active, we will use not only worksheets and work on memorization of facts but also use materials to solve real problems that show how mathematics is used at home and in the community. Our students will solve problems that challenge them to think and to use their experience and skills.
- On occasion, students will work in groups to solve problems, cooperating with other students. They will speak, write and read about mathematics as well as doing problems. We may play mathematics games, find community problems to create interest, and use flash cards for number facts.

Secondary teachers can adapt letter by narrowing focus to their subject.

Science

- Instruction in science will be "hands-on" and "minds-on" with students using materials to experience science, doing experiments and discussing their ideas and discoveries. Students will be encouraged to ask questions about the world around them and to learn how to find out and make up their own minds by experimenting and investigating. They will use their observations and knowledge gained to support their explanations.
- Besides learning the basics, student activities will focus on understanding scientific concepts and the skills necessary to inquire about the natural world. Students will work in groups to discuss and critique their investigations. In addition to pencil and paper tests, students will demonstrate what they know and are able to do by completing projects and other kinds of assessments.

Add specific details about your own classroom practice.

As a teacher, I believe **all** children can learn mathematics and science with support, encouragement, good materials, and instruction. Understanding mathematics and science is vital for their future. What can parents do to help? Here are a few ideas:

- *Encourage questioning and persistence.* Sometimes we tell them what they've done wrong and forget to encourage them to continue their good work. Children grow and flourish with encouragement.
- *Have high expectations.* Tell your children they can succeed. Help them to do the work needed to succeed.
- *Reinforce science and mathematics learning at school with family activities,* such as a trip to the science museum, to the library or a walk in the park. Find ways to incorporate mathematics and science into everyday activities.

See p. 37 for more tips on what parents can do to support improved mathematics and science education.

Please feel free to stop by or call me at [phone number] if you'd like to learn more about our mathematics and science program this year. Parents are always welcome to visit our classroom.

Sincerely,

[teacher's name]

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PARENT NEWSLETTER ARTICLES AND HANDOUTS

■

The purpose of home activities such as these is to encourage young people to learn at home as well as at school. Children can be encouraged by parents to use these inquiry skills in just about any family situation – a trip to the grocery store, a walk, car trip or visit to a museum. By stimulating a child's curiosity, inquiry turns everyday activities into learning opportunities for children and adults.

Statistical smarts

Sports scoreboards, weather reports, and newscasts bombard us everyday with statistical information. Students need to know how to interpret and draw conclusions from this information so that they can become knowledgeable consumers and citizens.

The study of statistics and probability allows children to begin to raise and answer questions about things of interest in their own environment.

Here's an everyday example you can do at home. Have your family compare your town to a city where a relative or family friend lives. Check the newspaper for the daily high and low temperatures in the two cities. Compare temperatures for a few weeks. Do you notice any patterns? What can you predict about next week's weather? What kinds of conclusions can you draw from the data?

The long and short of it

To measure length, area, volume, weight, or angles, we choose a tool (such as a yardstick or ruler) marked off in a given unit (inches, degrees) and count the number of those units it takes to measure something.

Here are some family measuring activities to try. Personal measurements of the family can be made by the children in order to answer questions such as the following:

- Which member of your family has the broadest smile?
- Which member of your family has feet longer than yours? Which member of your family has feet shorter than yours? How can you record your findings?
- What is the circumference (in centimeters) of the wrist of each family member?

Think about it — today's records will be tomorrow's personal history of your family.

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PARENT NEWSLETTER ARTICLES AND HANDOUTS

The Slime from Tomorrow

Slime, made of a mixture of corn starch and water, is simple to make and will illustrate some interesting scientific principles. Corn starch slime is a special type of mixture called a suspension. It has properties of both a solid and a liquid. It can break apart like a solid, but it also will ooze through your fingers like a thick liquid.

What you need:

1 cup of corn starch
1/4 cup of warm water
1 drop of green food coloring
a mixing bowl
wax paper

Making Slime:

1. Add the food coloring to the water and stir.
2. Place the corn starch in the bowl and slowly add the water, using your fingers to mix.
3. Dump the slime onto the wax paper.

What To Do With It When It's Made:

Here are some fun ways to test the special properties of your slime suspension.

- Let it ooze slowly through your fingers.
- Smack it on a flat surface.
- Make it into a ball and then watch it flatten out.
- Cut it up.
- Stretch it.
- Put a marble on top of it and watch what happens.

Whatever you do, don't let it get away.

Note to Parents: Corn starch slime is completely biodegradable, so you can wash it down the drain when your child is done playing with it. Add lots of water or it will clog the pipes. (Caution: Run hot water for some time to be sure slime is dissolved and through the pipes.) But you also can preserve it in a ziplock bag in the refrigerator, if you wish.

reprinted with permission from the Connecticut Academy for Education in Mathematics, Science & Technology

These types of articles encourage families to "do" science and math at home.

Ask questions like, Why do you think that happens?, What would happen if...? and, Can you think of everyday things in the world that have these properties or react in these ways?

PARENT NEWSLETTER ARTICLES AND HANDOUTS

This could be photocopied and sent home as a hand-out.

How to encourage your child's interest in mathematics and science

Support positive attitudes

- Avoid saying negative things like "I was never good at math," or "Chemistry never made much sense to me either."
- Reward your child with encouragement when he or she is successful. "I'm really proud of the way you figured out that problem." "I admire how hard you had to work to construct that tower."
- Encourage your child to be persistent when the work becomes difficult.

Monitor television viewing

- Students who spend less time watching TV and playing video games do better in school. Try replacing them with other activities.
- Encourage viewing of educational programming like PBS's Newton's Apple and Nye the Science Guy.

Participate and intereact with your child

Elementary age children

- Work together in the kitchen. When children cook, they are learning to measure, time, and see chemical changes.
- Choose toys that encourage active learning: puzzles, board games, magnifying lenses, blocks, and inexpensive calculators.
- Allow children to create their own toys from clean milk cartons, plastic bottles, cardboard boxes, styrofoam containers, etc.
- Work in the garden together. Plant an indoor herb garden, force a bulb during the winter, or root a potato in a jar of water. (You'll find books in the library with instructions for these and other activities.)
- Encourage collections. Most children love to gather leaves, buttons, coins, sticks, and other objects they can sort, group, count, and label.

Middle school age

- Work together on household repairs. With supervision, your child can learn to rewire a light switch, make bicycle repairs, or do simple carpentry.
- Encourage your child to select games and activities that are interesting and challenging like chess, checkers, Monopoly, and card games.
- Encourage observations and interpretations of the natural world — behaviors of animals in your backyard or different trees and plants in the park.
- Teach children about household finances. Discuss some purchase choices with them — hamburger or veggie burger? A new dress or a pair of winter boots?
- Encourage your child to read. Subscribe to magazines like Popular Science, Popular Mechanics, Omni, National Geographic, and Zillions. Or look for them at your public library or on the Internet.

High school age

- Make it clear that you expect your high schooler to attend school every day.
- Encourage teenagers to take challenging mathematics and science courses, whether or not they plan on college.
- Stay involved in your child's school by attending school events and monitoring progress in mathematics and science courses.
- Provide magazines, newspapers, and books in your home for your child to read.
- Encourage your child to talk with a relative, friend, or other adult who uses mathematics or science daily. This could be a nurse, a tool and die maker, a building maintenance worker, a farmer, an engineer, a chef, a computer programmer — the possibilities are almost endless.
- Choose gifts that promote learning, like calculators, puzzles, CD-ROMS, microscopes and strategy games. Serious adult tools such as wrenches, screw drivers, and old appliances are a good choice for teenagers who like to tinker.
- Encourage your child to participate in mathematics and science activities offered by your community center, science museum, local library, or school district. Also encourage participation in science fairs and mathematics olympiads.
- Encourage teens to mentor a younger student in mathematics or science.

Standards

Instructional Practices

Assessment

Equity

Communicating With Parents and Community

Collaboration and Leadership

This section presents selected resources that may be helpful to educators as they work for standards-based change.

STANDARDS

Assessment Standards For School Mathematics, 1995. National Council of Teachers of Mathematics (NCTM), 1906 Association Drive, Reston, VA 22091-1593; 1-800-235-7566 or 703-620-9840; http://www.nctm.org/

Benchmarks for Science Literacy, 1993. American Association for the Advancement of Science (AAAS) Project 2061. Available from Oxford University Press, Dept. KWH, 198 Madison Ave., New York, NY 10016-4314; 1-800-230-3242; AAAS Internet home page http://www.aaas.org/

Curriculum and Evaluation Standards For School Mathematics, 1989. National Council of Teachers of Mathematics (NCTM), 1906 Association Drive, Reston, VA 22091-1593; 1-800-235-7566 or 703-620-9840; http://www.nctm.org/

Minnesota Graduation Standards, 1995. Includes Basic Standards, and high standards in the Profile of Learning. Minnesota Department of Children, Families and Learning, 733 Capitol Square, 550 Cedar Street, St. Paul, MN 55101; 612-296-1447 or 1-800-657-3927; E-mail: children@state.mn.us http://children.state.mn.us/grad/gradhom.htm

National Science Education Standards, 1996. National Academy of Sciences (NAS) and National Research Council (NRC). Includes standards for teaching, professional development, assessment, content, programs and systems. Available from National Academy Press, 2101 Constitution Avenue, NW, Box 285, Washington, DC 20055; 1-800-624-6242 or 202-334-3313; http://www.nas.edu/nap/bookstore

Professional Standards For Teaching Mathematics, 1991. National Council of Teachers of Mathematics (NCTM), 1906 Association Drive, Reston, VA 22091-1593; 1-800-235-7566 or 703-620-9840; http://www.nctm.org/

INSTRUCTIONAL PRACTICES

Doing What Scientists Do, 1991. Doris, Ellen. The Northeast Foundation for Children. Available from Heinemann Educational Books, Inc., 361 Hanover Street, Portsmouth, NH 03801-3912; 603-431-7894.

Elementary School Science for the '90's, 1990. The NETWORK, Publications Department, 300 Brickstone Square, Suite 900, Andover, MA 01810; 508-470-1080.

Full Option Science System/Britanica Science System (FOSS). Elementary science kit program with associated multimedia materials. Distributed by Instructional Materials Division, Jeff Lorton, regional manager; 612-824-6180.

Getting Started: A Blueprint for Elementary School Science Education, 1989. The National Center for Improving Science Education, a partnership of The NETWORK, Inc. and The Biological Sciences Curriculum Study (BSCS.) Available from The NETWORK, Publications Department, 300 Brickstone Square, Suite 900, Andover, MA 01810; 508-470-1080.

INSIGHTS. Elementary science curriculum kit covering topics which reflect balance of life, physical, and earth sciences. Distributed by Optical Data Systems, Dick Heinricks, regional representative; 612-235-2389 or 1-800-524-2481.

Minnesota K-12 Mathematics and Science Curriculum Frameworks, Available in Spring 1997. SciMath^MN, 638 Capitol Square, 550 Cedar Street, St. Paul, MN 55101; 612-296-4058; E-mail: scimath-mn@informns.k12.mn.us http://www.informns.k12.mn.us/scimathmn

National Science Teachers Association (NSTA) Pathways to the Science Standards: Guidelines for Moving the Vision into Practice, 1996. National Science Teachers Association, 1840 Wilson Boulevard, Arlington, VA 22201; 1-800-722-6782 or 703-243-7100; http://www.nsta.org/index.shtm

National Council of Teachers of Mathematics Curriculum and Evaluation Standards For School Mathematics Addenda Series: Grades K-6 Series; Grades 5-8 Series; Grades 9-12 Series. National Council of Teachers of Mathematics (NCTM), 1906 Association Drive, Reston, VA 22091-1593; 1-800-235-7566 or 703-620-9840; http://www.nctm.org/

National Science Foundation Funded Mathematics Curriculum Projects:

Elementary Level (K-5):

Everyday Mathematics. Everyday Learning Corporation; 1-800-382-7670

Investigations in Number, Data and Space. Dale Seymour; 1-800-872-1100

Teaching Integrated Mathematics and Science Project (TIMS). Kendall Hunt; 1-800-228-0810

Middle School Level (6-8):

Achieved Curriculum. Encyclopedia Britannica; 1-800-554-9862 ext. 7007

Connected Mathematics Project (CMP). Dale Seymour; 1-800-872-1100

Mathematics Through Application Project. Institute for Research on Learning; 415-496-7900

Seeing and Thinking Mathematically (STM). Heinemann; 1-800-847-0938

Six Through Eight Mathematics (STEM). McDougal Littell; 1-800-323-5435

High School Level (9-12):

Applications/Reform in Secondary Education (ARISE). COMAP; 617-862-7878

Connected Geometry. Janson Publishers; 1-800-322-MATH

Core Plus Mathematics Project. Janson Publishers; 1-800-322-MATH

Interactive Mathematics Project (IMP). Key Curriculum Press; 1-800-995-MATH

Math Connections. CBIA Education Foundation and the Hartford Alliance for Mathematics and Science Education; 203-244-1900

Selections from the National Science Foundation Funded Science Curriculum Projects:

Elementary

Developmental Approaches in Science and Health (DASH). A comprehensive program designed to develop scientific literacy for K-3 students by facilitating the learning and application of basic concepts and skills in science, health, and technology in authentic and practical ways. Grades K-3. Curriculum Research and Development Group, University of Hawaii; 808-956-6918.

Life Lab Science Program. A school grounds/classroom transformed into garden laboratories; observation, collection and analysis of data based on curriculum guide. Grades 2-6. Life Lab Science Program. Lisa Glick or Gary Appel, 1156 High Street, Santa Cruz, CA 95064; 408-459-2001.

Middle School

Foundations and Challenges to Encourage Technology-based Science (FACETS). American Chemical Society, Washington, DC. Grades 5-8; 1-800-227-5558.

Foundational Approaches in Science Teaching (FAST). A course in the concepts and methods of the physical, biological, and earth sciences and their relation to the environment. Grade 7. Curriculum Research and Development Group, University of Hawaii; 808-956-7863.

Investigating and Evaluating Environmental Issues and Actions. An interdisciplinary environmental issues and action curriculum focused on enhancing students' responsible behavior through the examination and evaluation of real life community-based environmental problems and issues. Grades 7-8. (It has also been used in grades 5-6.) Southern Illinois University; 618-453-4214.

JEFFCO Middle School Life Science Program. A program that enables students to understand the human body, basic ecological principles, and issues associated with environmental problems, and to make decisions to improve health-related behaviors. This program is a year-long life science program. Grades 7-8. Middle School Life Science, Wheat Ridge, CO; 303-467-1184.

Secondary

Geology Is. An introductory geoscience course designed to become a part of the secondary school curriculum and provides geoscience learning opportunities not presently available in the secondary science curriculum. Grades 9-12. O'Fallon Township High School; 618-632-3507.

Just Physics. American Association of Physics Teachers and the American Institute of Physics. Grades 9-10; 1-800-809-2247.

Physics Resources and Instructional Strategies for Motivating Students (PRISMS). A comprehensive physics program that stimulates students to develop reasoning and problem-solving skills while providing learning activities about practical applications of physics. Grades 10-12. PRISMS, Physics Department, University of Northern Iowa; 319-273-2918.

NSRC's Science and Technology for Children (STC). Elementary science kit including 24 curriculum units for grades 1-6, focusing on the "Focus-Explore-Reflect-Apply" learning cycle. Distributed by Carolina Biological; 1-800-334-5551.

Resources for Teaching Elementary School Science, 1996. National Academy Press, 2101 Constitution Avenue NW, Box 285, Washington, DC 20055; 1-800-624-6242 or 202-334-3313; http://www.nas.edu/nap/bookstore

Teaching Elementary Science: who's afraid of spiders? Ivany, J.W., George and Selma Wassermann. 1988. Harper & Row Publishers, New York, NY; 212-207-7000.

What Will Happen If... Young children and the scientific method, 1985. Educational Equity Concepts, Inc. Available from Gryphon House, Inc., 3706 Otis Street, P.O. Box 275, Mt. Ranier, MD 20712; 301-779-6200.

ASSESSMENT

Active Assessment For Active Science, 1994. Hein, George E. and Sabra Price. Heinemann, 361 Hanover Street, Portsmouth, NH 03801-3912; 1-800-847-0938 or 603-431-7894.

Assessing Habits of Mind: Performance-based assessment in science and mathematics, 1994. Jorgensen, Margaret. ERIC/CSMEE Clearinghouse for Science, Mathematics, and Environmental Education, The Ohio State University, 1929 Kenny Road, Columbus, OH 43210-1080; 1-800-276-0462; http://www.ericse.org/

Assessment in the Mathematics Classroom (K-12). National Council of Teachers of Mathematics 1993 Yearbook. Available from National Council of Teachers of Mathematics (NCTM), 1906 Association Drive, Reston, VA 20191-1593; 703-620-9840 or 1-800-235-7566; http://www.nctm.org/

Assessment in Science Education: The Middle Years. Available from The NETWORK, Publications Department, 300 Brickstone Square, Suite 900, Andover, MA 01810; 508-470-1080.

The Assessment of Hands-On Elementary Science Programs, August 1990. Hein, George. Center for Teaching and Learning, University of North Dakota. Available from North Dakota Study Group, Box 8158, University of North Dakota, Grand Forks, ND 58202. (mail inquiries only)

First Grade Takes a Test. Cohen, Miriam and Lillian Hoben, eds. Dell Publishing, 666 Fifth Ave., New York, NY 10103; 212-354-6500.

Mathematics Assessment: Myths, Models, Good Questions, and Practical Suggestions (K-12), 1991. Jean Kerr Stenmark, ed. National Council of Teachers of Mathematics (NCTM), 1906 Association Drive, Reston, VA 20191-1593; 703-620-9840 or 1-800-235-7566; http://www.nctm.org/

Measuring Counts, 1993. Mathematical Sciences Education Board and National Research Council. Available from National Academy Press, 2101 Constitution Avenue NW, Box 285, Washington, DC 20055; 1-800-624-6242 or 202-334-3313; http://www.nas.edu/nap/bookstore

Measuring Up: Prototypes for Mathematics Assessment, 1993. Mathematical Sciences Education Board and National Research Council. Available from National Academy Press, 2101 Constitution Avenue NW, Box 285, Washington, DC 20055; 1-800-624-6242 or 202-334-3313; http://www.nas.edu/nap/bookstore

New Ways Students Know and Can Do. Brown, Janet H. and Richard Shavelson. Located in *Instructor*, March 1994, pp. 58-61. Two separate publications for elementary and intermediate levels, published eight times per year by Scholastic Inc., 2931 E. McCarty St., P.O. Box 3710, Jefferson City, MO 65102; 1-800-544-2917; http://scholastic.com/instructor

Science Assessment in the Service of Reform, 1991. Kulm, Gerald and Shirley M. Malcom, eds. American Association for the Advancement of Science, 1333 H Street, NW, Washington, DC 20005; 1-800-451-7556 or 202-326-6640; http://www.aaas.org/

Science & Children: Assessment Issue, October 1994, Vol. 32 No. 2. A publication of the National Science Teachers Association, 1840 Wilson Blvd., Arlington, VA 22201-3000; 1-800-722-6782 or 703-243-7100; http://www.nsta.org/pubs/sc/

Science Scope: Special Issue on Assessment, March 1992, Vol. 15 No. 6. A publication of the National Science Teachers Association, 1840 Wilson Blvd., Arlington, VA 22201-3000; 1-800-722-6782 or 703-243-7100; http://www.nsta.org/pubs/scope/

What We've Learned About Assessing Hands-On Science. Baxter, Gail P. and Richard J. Shavelson. Located in Education Leadership, May 1992, Vol. 49, No. 8., pp. 20-25. A publication of the Association of Supervision and Curriculum Development (ASCD), 1250 N. Pitt St., Alexandria, VA 22314-1453; 1-800-933-2723; http://www.ascd.org/pubs/el/elintro.html

EQUITY

Breaking the Barriers: Helping Female and Minority Students Succeed in Mathematics and Science. Clewell, Beatriz C., Anderson, Bernice Taylor, & Thorpe, Margaret E. (1992). San Francisco: Jossey-Bass. Today's global marketplace demands workers who are scientifically literate, yet few are being adequately prepared to meet that demand. Particularly underrepresented are women and minorities. This book demonstrates that early intervention, especially during grades four through eight, can help overcome some of these obstacles.

Directorate of Education and Human Resources Programs (EHR). This listing of selected publications and resources on science, mathematics and technology education is available from American Association for the Advancement of Science, 1333 11 Street NW, Washington, DC 20005; 1-800-451-7556 or 202-326-6640; http://www.aaas.org/

Equity in Education Series. Developed by the WEEA Equity Resource Center, the series of booklets include: *Gender Equity for Educators, Parents and Community; Gender Stereotypes: Links to Violence; School to Work: Equitable Outcomes; and Gender-Fair Math.* Available from WEEA Publishing Center, EDC, 55 Chapel St., Suite 282, Newton, MA 02158; 1-800-225-3088. Single booklet is $4.00. Entire set of 4 booklets is $13.00.

Equity Materials in Mathematics, Science and Technology: A Resource Guide. This extensive, on-line guide is provided by the Resource Center, Rutgers Consortium for Educational Equity, New Brunswick, NJ. The Guide is on the Equity Assistance Center's (EAC) Internet home page at http://www.carnscape.com/eacmat1.html or by calling the Resource Center at 908-445-2071.

Lifting the Barriers: 600 Strategies that Really Work to Increase Girls' Participation in Science, Mathematics and Computers. Sanders, Jo. (1994). Port Washington, New York: Jo Sanders Publications. A how-to book with 600 tested strategies to increase girls' participation in science, mathematics, and computers.

Making Mathematics Work for Minorities: Framework for a National Action Plan. Mathematical Science Education Board. National Research Council. (1994). The outline of a national action plan for improving mathematics education of minorities at all academic levels. Available from the National Academy Press, 2101 Constitution Avenue, NW, Box 285, Washington, DC 20055; 1-800-624-6242 or 202-334-3313; http://www.nas.edu/nap/bookstore

Reaching All Students with Mathematics. Cuevas, Gilbert & Driscoll, Mark. eds. 1993. Collection of articles born of the conviction that all students can learn a significant core of high-quality mathematics. Available from the National Council of Teachers of Mathematics (NCTM), 1906 Association Drive, Reston, VA 22091-1593; 1-800-235-7566 or 703-620-9840; http://www.nctm.org/

Research Letter. Published periodically by the National Action Council for Minorities in Engineering, Inc. (NACME). 3 West 35th Street, New York, NY 10001-2281; 212-279-2626. NACME offers a large selection of resources on equity in education. Call for a full listing of available publications.

Science for All Americans, 1989. American Association for the Advancement of Science (AAAS) Project 2061. Available from Oxford University Press, Dept. KWH, 198 Madison Ave., New York, NY 10016-4314; 1-800-230-3242; AAAS Internet home page http://www.aaas.org/

Science Success for Students with Disabilities. Weisgerber, Robert A. (1993). Menlo Park, California: Addison Wesley. This book describes classroom barriers commonly encountered by students with vision, hearing, speech, physical, or emotional disabilities. The guide provides easily accessible, classroom-tested strategies that show how to recognize science potential in disabled students and plan science curriculum that includes all learners.

SciMath^{MN} Report on Equity Issues in Science and Mathematics Education in Minnesota, 1997. Prepared by Dr. Robert Johnson of St. Cloud State University. Available from SciMath^{MN}, 638 Capitol Square, 550 Cedar Street, St. Paul, MN 55104; 612-296-4058; E-mail: scimath-mn@informns.k12.mn.us http://www.informns.k12.mn.us/scimathmn

Windows of Opportunity: Mathematics for Students with Special Needs. Thornton, Carol A. & Bley, Nancy S. eds. 1994. National Council of Teachers of Mathematics. A professional resource for classroom and special education teachers who work with students with disabilities in mathematics or who are gifted in mathematics. Available from The National Council of Teachers of Mathematics (NCTM), 1906 Association Drive, Reston, VA 22091-1539; 1-800-235-7566 or 703-620-9840; http://www.nctm.org/

COMMUNICATING WITH PARENTS AND COMMUNITY

Calculating Change. This video is a call to action that shows how parents and communities can work together to promote better, more creative math and science education. Available from The Annenberg/CPB Math and Science Collection, P.O. Box 2345, S. Burlington, VT 05407-2345; 1-800-965-7373; FAX 802-864-9846. http://www.learner.org/k12
One hour VHS cassette is $24.95.

Can We Change? Yes, But... This brochure is for parents, educators, administrators and community members who aren't aware or convinced that we need to change the mathematics we teach and how we teach it. Available from The Annenberg/CPB Math and Science Collection, P.O. Box 2345, S. Burlington, VT 05407-2345; 1-800-965-7373; FAX 802-864-9846. http://www.learner.org/k12
One free copy or $6.50 for 100.

Helping Your Child Learn Science and *Helping Your Child Learn Math.* Both are available in English and Spanish from the Office of Educational Research and Improvement, U.S. Department of Education; 202-219-1556; full text and illustrations on-line at http://www.ed.gov/pubs/parents.html

Math and Science - Start Now, 1992. Navy Recruiting Command. Aimed at students, this powerful videotape can also communicate to parents the importance and relevance of math and science education today. Sam Wright, voice of Sebastian the Crab from Disney's *The Little Mermaid,* makes the point that math and science is the foundation for career choices from auto mechanic to astronaut. Prominently featured is Dr. Kathryn Sullivan, NASA astronaut. When requesting loan of this tape, specify PIN #802033, the program title, the tape format you desire (VHS, etc.), and desired and alternate exhibition dates. Available from: Dir/NETPMSA VI Unit - Norfolk, 9770 Decatur Ave. Suite 250, Norfolk VA 23511-3292; 804-444-4011.

**SciMath[MN] has produced a video that can be shown to parents and other community members to help them understand how schools are linking inquiry learning in the classroom to the way people learn at home, in the workplace, and in the community. This 15-minute video is available from SciMath[MN], 638 Capitol Square, 550 Cedar Street, St. Paul, MN 55101; 612-296-4058;
E-mail: scimath-mn@informns.k12.mn.us
Internet: http://www.informns.k12.mn.us/scimathmn**

Parents as Leaders in Science and Mathematics Education Reform: PRISM Parent Outreach Kit, 1994. Developed by the National Urban League, this kit includes three short videotapes: "Math and Science at Home," "Math and Science in School," and "Math and Science in the Community." Also includes "A Sourcebook for Parent and Community Leaders," which helps facilitators plan community workshops for parents on science and math, and a set of reproducible outreach sheets with tips for parents. Available in English and Spanish from the Annenberg/CPB Math and Science Collection, P.O. Box 2345, S. Burlington, VT 05407-2345; 1-800-965-7373; FAX 802-864-9846. http://www.learner.org/k12
One free copy of each of ten outreach sheets.
Full PRISM Kit $59.95.

Science & Children: Families Involved in Real Science Together. October 1996, Vol. 34 No. 2. A publication of the National Science Teachers Association, 1840 Wilson Blvd., Arlington, VA 22201-3000; 1-800-722-6782 or 703-243-7100; http://www.nsta.org/pubs/sc/

Science Simply Amazing. Part of the National Science Education Standards Awareness Kits, this kit includes a brochure, booklet and video to help parents become aware of how children best learn science. Available from The Annenberg/CPB Math and Science Collection, P.O. Box 2345, S. Burlington, VT 05407-2345; 1-800-965-7373; FAX 802-864-9846; http://www.learner.org/k12 $29.95

"What Should I Look for in a Math Classroom?" This brochure for parents is available in English and Spanish from The Annenberg/CPB Math and Science Collection, P.O. Box 2345, S. Burlington, VT 05407-2345; 1-800-965-7373; FAX 802-864-9846; http://www.learner.org/k12
One free copy or $6.50 for 100.

COLLABORATION AND LEADERSHIP

Collaboration: What Makes it Work, 1994. Triangle Coalition. This video highlights the importance of collaboration as a tool for facilitating systemic change in education. Available from The Triangle Coalition for Science & Technology Education, 5112 Berwyn Road, 3rd Floor, College Park, MD 20740-4129; 301-220-0870; E-mail: tricoal@aol.com

Communications Handbook, 1993. This booklet provides tools needed to reach out to the media; initiate and maintain positive relationships with reporters; educate the public through speeches, press releases, and interviews; and help participants establish themselves as relevant, informed sources of mathematics education information. Available from the National Council of Teachers of Mathematics (NCTM), 1906 Association Drive, Reston, VA 22091-1593; 1-800-235-7566 or 703-620-9840; http://www.nctm.org/

Community Update newsletter. Published monthly by the Office of Intergovernmental and Interagency Affairs, U.S. Department of Education, Washington, D.C. 20202-0498; 1-800-USA LEARN; http://www.ed.gov/newsletters.html

Creating a Climate for Change...Math Leads the Way. Developed by The Math Connection and WQED/Pittsburgh, this video and guide provide all the information and materials for six workshops for key groups, including professional development workshops for preservice and in-service math educators. Can also serve as information resource for presentations to parents, community and business leaders, school board members and policymakers. Available from The Annenberg/ CPB Math and Science Collection, P.O. Box 2345, S. Burlington, VT 05407-2345; 1-800-965-7373; FAX 802-864-9846.
http://www.learner.org/k12
Kit with VHS cassette and facilitator's guide is $50.00.

The Annenberg/CPB Math and Science Collection of products educate and support groups of adults who have a hand in changing the way mathematics and science are taught, including parents, teachers, teacher educators, administrators and policymakers. To receive the catalogue of the complete Annenberg/CPB Math and Science Collection, write or call P.O. Box 2345, S. Burlington, VT 05407-2345; 1-800-965-7373; FAX 802-864-9846. http://www.learner.org/k12

Effective Public Engagement, 1993. Prepared for the New Standards Project by The Public Agenda Foundation. This document provides an overview of commonly asked questions and concerns about standards in a Q & A format. Available from the Public Agenda Foundation, 6 East 39th Street, New York, NY 10016; 212-686-6610 or FAX 212-889-3461.

Eisenhower National Clearinghouse for Mathematics and Science Education. A national repository for current mathematics and science resources available to educators, students, parents and others. The Ohio State University, 1929 Kenny Road, Columbus, OH 43210-1079; 1-800-621-5785; http://www.enc.org/

Everybody Counts: A Report to the Nation on the Future of Mathematics Education, 1989. National Academy Press, 2101 Constitution Avenue NW, Box 285, Washington, DC 20055; 1-800-624-6242 or 202-334-3313; http://www.nas.edu/nap/bookstore

Facilitating Systemic Change in Science and Mathematics Education: A Toolkit for Professional Developers, 1995. The Regional Laboratory for Educational Improvement of the Northeast and Islands. The NETWORK, Publications Department, 300 Brickstone Square, Suite 900, Andover, MA 01810; 508-470-1080.

IDEAAAS: A Sourcebook for Science, Mathematics and Technology Education, 1995. Barbara Walthall, editor. American Association for the Advancement of Science (AAAS) and The Learning Team. This guide lists over 10,000 nationwide activities, materials, and programs involved in reform efforts. Available from The Learning Team, Inc., 10 Long Pond Road, Armonk, NY 10504; 914-273-2226. Single copies are $24.95 plus $4.00 shipping and handling.

The Guide to Math and Science Reform. This interactive computer database provides information on more than 700 reform initiatives, organizations and conferences. Available from The Annenberg/CPB Math and Science Collection, P.O. Box 2345, S. Burlington, VT 05407-2345; 1-800-965-7373; FAX 802-864-9846. Macintosh and Windows versions. $9.95. Available on-line at http://www.learner.org/content/k12/theguide/

Local Leadership for Science Education Reform, 1995. Anderson, Ronald D. and Harold Pratt. National Science Supervisors Association. Available from Kendall/Hunt Publishing Company, 4050 Westmark Drive, Dubuque, IA 52002; 1-800-228-0810.

A Look at Industry and Community Commitment to Educational Systemic Reform. The Triangle Coalition for Science & Technology Coalition, 5112 Berwyn Road, 3rd Floor, College Park, MD 20740-4129; 301-222-0870; E-mail: tricoal@aol.com

Educational Leadership: Networking Issue, November 1996, Vol. 54, No. 3. A publication of the Association of Supervision and Curriculum Development (ASCD), 1250 N. Pitt St., Alexandria, VA 22314-1453; 1-800-933-2723; http://www.ascd.org/pubs/el/elintro.html

Math and Science Standards: A Policymaker's Primer Booklet. Part of the Synergy Project, this booklet defines the standards for policymakers and lists five key ideas of the mathematics and science standards. Available from The Annenberg/CPB Math and Science Collection, P.O. Box 2345, S. Burlington, VT 05407-2345; 1-800-965-7373; FAX 802-864-9846; http://www.learner.org/k12. Booklet is $3.00.

Minnesota Academic Excellence Foundation (MAEF). A public-private partnership fosters partnerships between education, business and community. For information on current projects and publications, contact MAEF, 971 Capitol Square, 550 Cedar Street, St. Paul, MN 55101; 612-297-1875.

National Association of Partners in Education/MN (NAPE/MN). 7630 W. 145th St., Suite 202, Apple Valley, MN 55124; 612-891-3500. NAPE/MN is a partnership providing information and training for building education-to-business connections.

Minnesota Council of Teachers of Mathematics Math Times Newsletter. Published for members 4 times per year by Minnesota Council of Teachers of Mathematics (MCTM), P.O. Box 120418, New Brighton, MN 55112; 612-631-2136; E-mail: cutler@geom.umn.edu MCTM Internet home page available in 1997.

Minnesota Science Teachers Association Newsletter. Published for members 4 times per year by Minnesota Science Teachers Association (MSTA), 2400 Bourne St., St. Paul, MN 55108; 612-644-6254 or 612-296-8771; E-mail: ed.hessler@state.mn.us MSTA Internet home page available in 1997.

National Standards in American Education: A Citizen's Guide, 1995. Ravitch, Diane. The Brookings Institution, 1775 Massachusetts Ave. NW, Washington, DC 20036; 202-797-6000; http://www.brook.edu/

Office of Lifework Development, Minnesota Department of Children, Families and Learning, 684 Capitol Square, 550 Cedar Street, St. Paul, MN 55101; 612-215-0095. This organization assists teachers and others in locating and involving local business partners in schools.

Restructuring Mathematics: Making Change. This video for principals, curriculum developers, administrators, parents and community members shows how innovations in mathematics education help energize and enrich the entire school culture. Available from The Annenberg/CPB Math and Science Collection, P.O. Box 2345, S. Burlington, VT 05407-2345; 1-800-965-7373; FAX 802-864-9846; http://www.learner.org/k12 VHS cassette is $24.95.

SciMath^{MN} Catalyst newsletter. Published 3 times per year by SciMath^{MN}, 638 Capitol Square Building, 550 Cedar Street, St. Paul, MN 55101; 612-296-4058; E-mail: scimath-mn@informns.k12.mn.us http://www.informns.k12.mn.us/scimathmn

SciMath^{MN} Internet discussion group. Send and receive information on inquiry in math and science education with teachers and others. To subscribe, send a e-mail message to majordomo@informns.k12.mn.us Include in message: subscribe scimathmn <your first and last name>

SciMath^{MN} video. This video, to be released in 1997, encourages viewers to support education focused on standards-based change so that Minnesota schools will be aligned with the reality of a changing world. It invites audiences to consider how the world is changing and what these changes mean for the way we educate our children. It shows inquiry methods being used in classrooms. The video ends with a call to action, encouraging participation by all sectors of the community to support educational improvement. Available from SciMath^{MN}, 638 Capitol Square, 550 Cedar St., St. Paul, MN 55101; 612-296-4058; E-mail: scimath-mn@informns.k12.mn.us http://www.informns.k12.mn.us/scimathmn

School Communication Workshop Kit. National School Public Relations Association. This kit offers materials to conduct inservice training workshops to help school professionals and support staff, parents, administrators and board members to improve communication techniques. 1501 Lee Highway, Suite 201, Arlington, VA 22209-1100; 703-528-5840; FAX 703-528-7017.

Supporting Leaders in Mathematics Education: A Source Book of Essential Information, 1994. National Council of Supervisors of Mathematics (NCSM), P.O. Box 10667, Golden, CO 80401; 303-274-5932.

Transforming Teacher Education: A Minnesota Framework for Mathematics and Science, 1995. Published by SciMath^{MN}, this document offers a vision for what teacher education programs in Minnesota could be. It is intended as a guide for Minnesota post-secondary institutions as they consider the implications of national and state K-12 reform recommendations for teacher education programs. Available from SciMath^{MN}, 638 Capitol Square, 550 Cedar Street, St. Paul, MN 55101; 612-296-4058; E-mail: scimath-mn@informns.k12.mn.us http://www.informns.k12.mn.us/scimathmn

What Communities Should Know and Be Able to Do About Education Workbook. Part of the Synergy Project; this workbook provides step-by-step explanations of why community support is necessary and how to promote it. Available from The Annenberg/CPB Math and Science Collection, P.O. Box 2345, S. Burlington, VT 05407-2345; 1-800-965-7373; FAX 802-864-9846; http://www.learner.org/k12 Workbook is $10.00.

What Work Requires of Schools: A SCANS Report for America 2000, June 1991. U.S. Department of Labor, Secretary's Commission on Achieving Necessary Skills, 200 Constitution Avenue, NW., Washington DC 20210; 1-800-788-SKILL.

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